Overflow '73 - Denmark Strait: Volume 3 - Temperature, Salinity, and Sigma-t Sections

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Rapport technique canadien sur l'hydrographie et les sciences océaniques

Ces rapports contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles mais que l'on ne trouve pas normalement dans les revues scientifiques. Le sujet est généralement rattaché aux programmes et intérêts du service des Sciences et Levés océaniques (SLO) du ministère des Pêches et des Océans.

Les rapports techniques peuvent être considérés comme des publications à part entière. Le titre exact figure au-dessus du résumé du chaque rapport. Les résumés des rapports seront publiés dans la revue Résumés des sciences aquatiques et halieutiques et les titres figureront dans l'index annuel des publications scientifiques et techniques du Ministère.

Les rapports techniques sont produits à l'échelon régional mais sont numerotés et placés dans l'index à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page de titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Les établissements des Sciences et Levés océaniques dans les régions et à l'administration centrale ont cessé de publier leurs diverses séries de rapports depuis décembre 1981. Vous trouverez dans l'index des publications du volume 38 du *Journal canadien des sciences halieutiques et aquatiques*, la liste de ces publications ainsi que le dernier numéro paru dans chaque catégorie. La nouvelle série a commencé avec la publication du Rapport n° 1 en janvier 1982.

Canadian Technical Report of
Hydrography and Ocean Sciences 16

November, 1982

OVERFLOW '73 - DENMARK STRAIT:
VOLUME 3 - TEMPERATURE, SALINITY, AND SIGMA-T SECTIONS*

by

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ABSTRACT

Ross, C.K. 1982. Overflow '73 - Denmark Strait: Volume 3 - Temperature, salinity, and Sigma-t sections. Can. Tech. Rep. Hydrog. Ocean Sci. 16: 62 p.

The temperature, salinity and density (σ_t) data collected in Denmark Strait by CSS Hudson for the ICES Overflow 73 Experiment, during August and September 1973, are presented in this volume as oceanographic sections.

RÉSUMÉ

Ross, C.K. 1982. Overflow '73 - Denmark Strait: Volume 3 - Temperature, salinity, and Sigma-t sections. Can. Tech. Rep. Hydrog. Ocean Sci. 16: 62 p.

Nous présentons les sections océanographiques des données relatives à la salinité et à la densité (σ_t) qui ont été recueillis dans le détroit du Danemark par le NSC Hudson, en août et en septembre 1973, dans le cadre de l'expérience menée en 1973 pour le conseil international pour l'exploration de la mer.

TABLE OF CONTENTS

ABSTRACT ii

INTRODUCTION 1

DATA REDUCTION 2-3

GRAPHIC PRESENTATIONS 4

ACKNOWLEDGEMENTS 5

REFERENCES 5

LOCATION OF STATIONS

FIGURE 1. STATIONS 1-23 6

FIGURE 2. STATIONS 24-137 7

FIGURE 3. STATIONS 138-167 8

FIGURE 4. STATIONS 172-203 9

OCEANOGRAPHIC SECTIONS

STATIONS	PAGES		
	TEMPERATURE	SALINITY	SIGMA-T
2-4	10	26	42
5-12	10	26	42
13-17	11	27	43
18-23	11	27	43
24-30	12	28	44
31-37	12	28	44
38-45	12	28	44
47-57	13	29	45
58-67	14	30	46
68-74	15	31	47
75-77	15	31	47
78-83	16	32	48
84-94	16	32	48
94-100	17	33	49
100-104	17	33	49
105-108	18	34	50
111-120	19	35	51
138-145	20	36	52
147-157	21	37	53
158-167	22	38	54
174-181	23	39	55
188-193	24	40	56
194-198	25	41	57
199-203	25	41	57

INTRODUCTION

The ICES Expedition Overflow '73 was a multinational investigation of the overflow of water from the Norwegian Sea across the Greenland/Scotland ridge. The experiment took place between mid-August and mid-September, 1973. The Atlantic Oceanographic Laboratory of the Bedford Institute of Oceanography participated in the expedition on board the CSS Hudson.

This report presents vertical sections of the temperature, salinity and sigma-t data collected by Hudson in Denmark Strait. The other data collected by Hudson have been presented in two companion volumes (Coote and Hiltz, 1978; Ross, 1977). An account of the data collected by other institutions participating in Overflow '73 is given in Overflow '73 Inventory (ICES, 1976).

DATA REDUCTION

The CTP casts were made using a Howaldt Bathysonde T87 mounted on a rosette sampler equipped with 10 water sample bottles. The instrument was lowered and raised at a nominal speed of 1 m/s. The data from the CTP were logged using a PDP-8L computer at a rate of 4 scans per second of temperature, pressure and conductivity. The computer developed a fault in its memory stack so no CTP profiles were recorded for stations 1 to 23. A pinger on the rosette sampler cage allowed the water column to be profiled to within a few metres of the bottom. The rosette sampler was used to collect samples for chemical determinations and calibration points for the CTP. Each station generated 10 salinity and 5 temperature (and pressure on deeper samples) points.

The Bathysonde divides its operating ranges into nine subranges of temperature and conductivity of which about half were required in Denmark Strait. The calibration of each subrange was done in the laboratory and fitted by a polynomial. Bennett's (1976) equations were used to calculate salinity from conductivity, temperature and pressure.

The salinity, temperature and pressure values generated by the rosette sampler were used for the in situ calibration. The laboratory calibration for pressure was found to be acceptable and only a small adjustment was required for temperature. The conductivity sensor was calibrated by comparing the value from the CTP with that computed (via iterative method using Bennett's equations) at the in situ temperature and pressure to give the water sample's salinity. The calibrations for temperature and conductivity did change with time. However, for data processing, the frequency of change of calibration was kept to a minimum consistent with the expected accuracy of the instrument. The calibration data indicated an accuracy better than 0.02°C in temperature, 0.03°/$_{oo}$ in salinity and 5 decibars or 0.5% in pressure.

No allowance was made for the mismatch in time constants between the temperature and conductivity sensors. This mismatch was particularly noticeable in the strong thermal gradients above the overflow water. The resulting salinity spikes were manually edited out of the data.

GRAPHICAL PRESENTATIONS

Vertical section plots of temperature, salinity and sigma-t are presented. The order of presentation is grouped to have all temperature sections followed by salinity and concluded with sigma-t. Within each grouping the sections are ordered by increasing station number as much as possible. The geographical location of each station is shown in Figures 1 to 4.

The horizontal spacing between stations is found by performing a least squares straight line fit to all the stations forming the section and projecting each station onto this line. Sections that were occupied more than once used all stations to generate the section line. Each section plot shows a dot where the rosette sampler collected a value of the parameter being displayed. The bottom profile is generated by the sounding taken at each station.

Two vertical scales were used for presenting the data; one for sections less than 1000 m maximum depth and another for the deeper sections. The horizontal scale is correspondingly adjusted to maintain the same vertical exaggeration (1:125) on all plots.

ACKNOWLEDGEMENTS

I would like to thank all those who participated in collecting, processing and presenting the data. The excellent co-operation of the ship's company and scientific party during the data collection is very much appreciated. Several people have been involved in processing and editing the data as it passed through a number of software systems and computers. Mr. John Pritchard accomplished the layout of the diagrams in this data report.

REFERENCES

Bennett, A. S. 1976. Conversion of in situ measurements of conductivity to salinity. Deep-Sea Research, 23 (2): 157-165.

Coote, A. R. and R. S. Hiltz. 1978 Overflow 73 - Denmark Strait, Volume 1: Oxygen and Nutrient Sections. Bedford Institute of Oceanography, Data Series BI-D-78-4, 37 pp.

ICES. 1976. Overflow '73 Inventory. ICES Oceanographic Data Lists and Inventories, No. 29, 203 pp.

Ross, C. K. 1977. Overflow 73 - Denmark Strait, Volume 2: Moored instrument Time Series. Bedford Institute of Oceanography, Data Series BI-D-77-5, 187 pp.

Figure 1: Phase I station positions,
August 10 to August 16, 1973.

Figure 2: Phase IIa station positions,
August 21 to September 5, 1973.

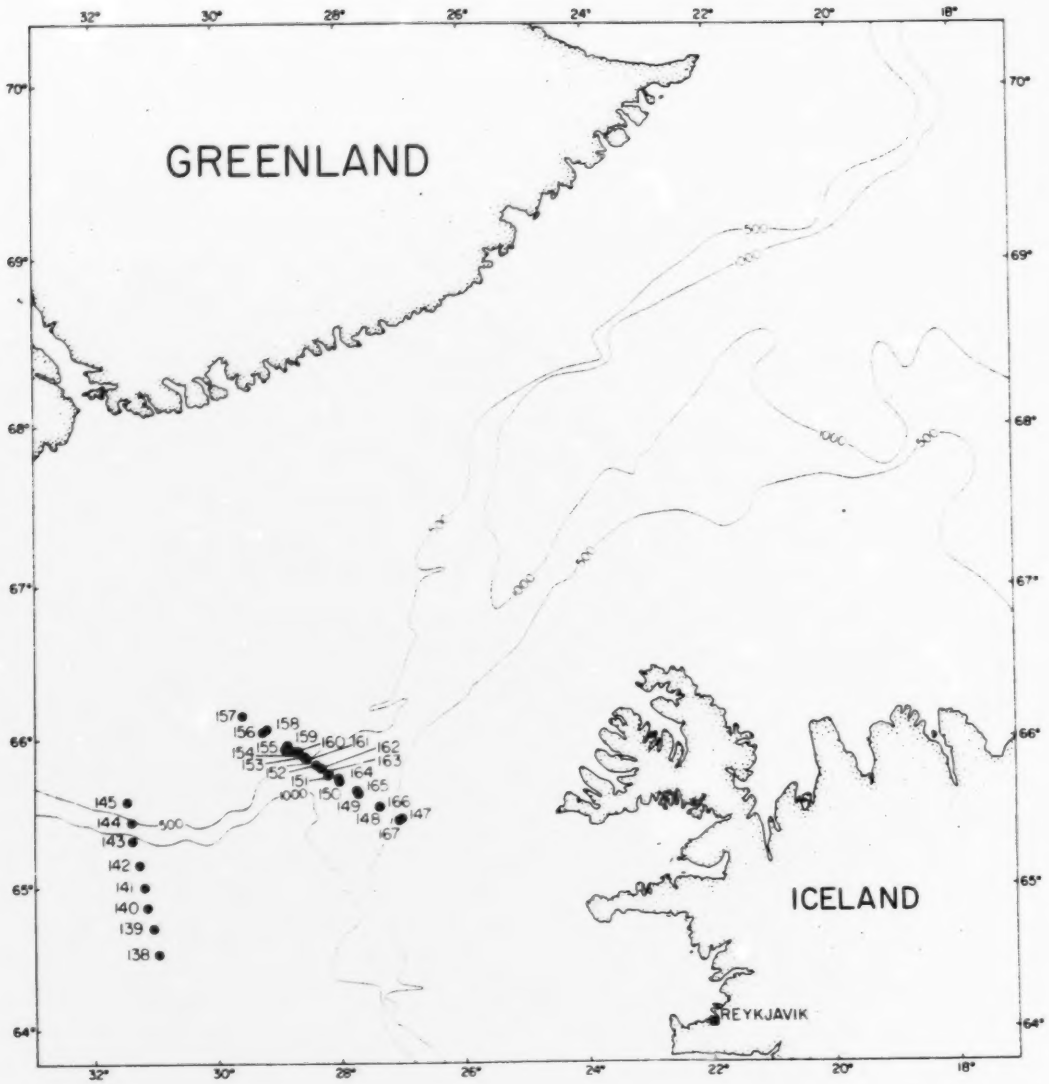


Figure 3: Phase IIb station positions,
September 5 to September 9, 1973.

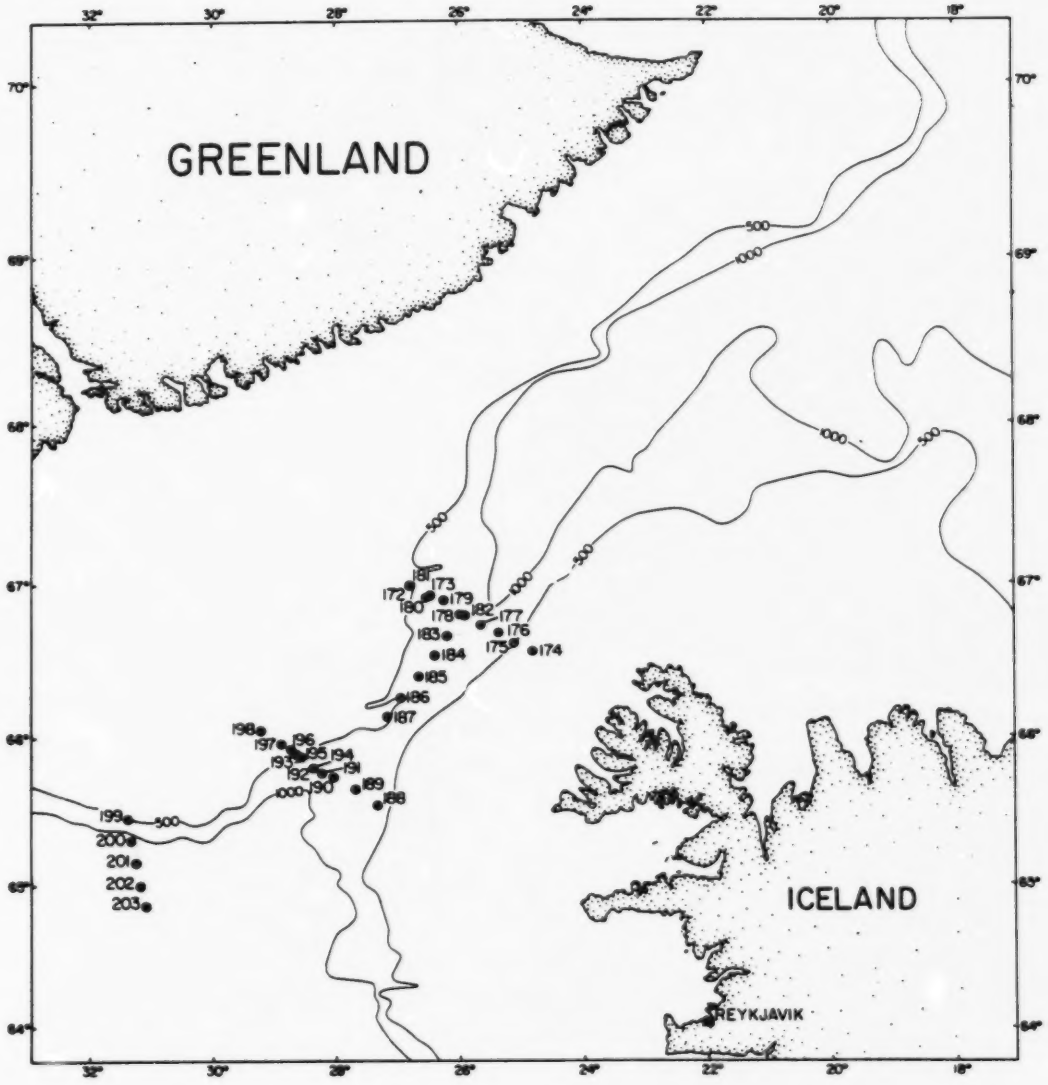
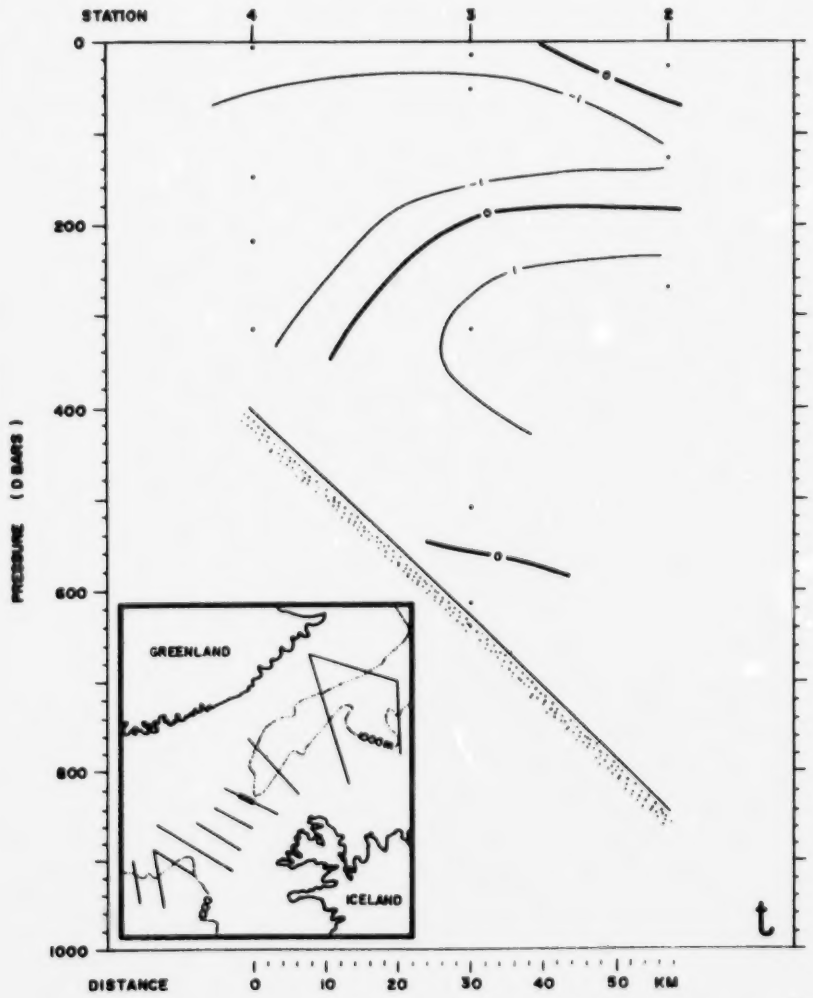


Figure 4: Phase III station positions,
September 15 to September 20, 1973.

CRUISE 18-10-73025-OVERFLOW 73



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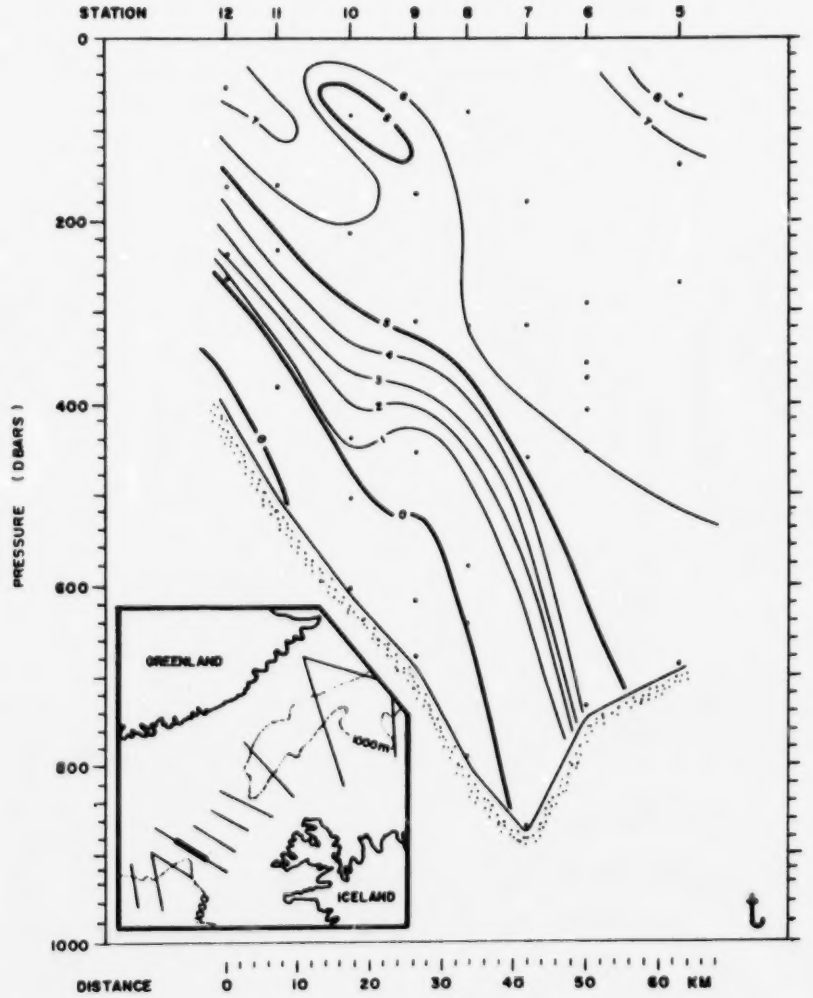
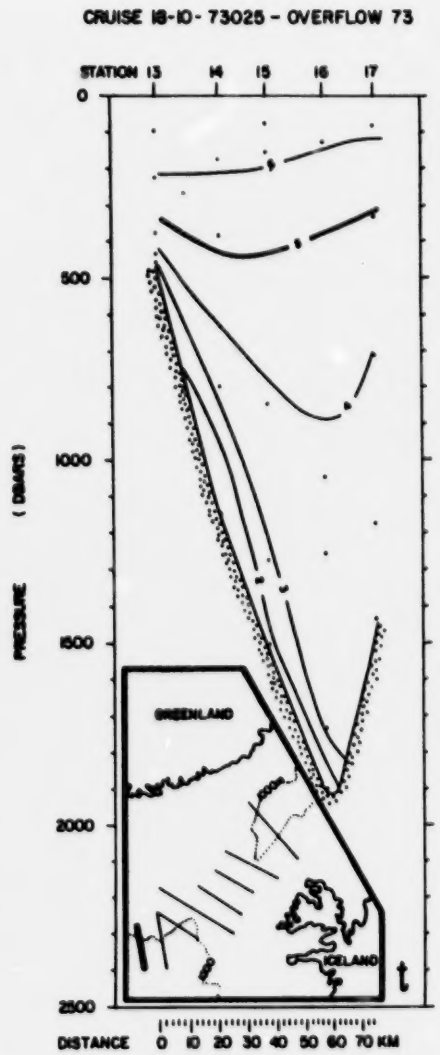
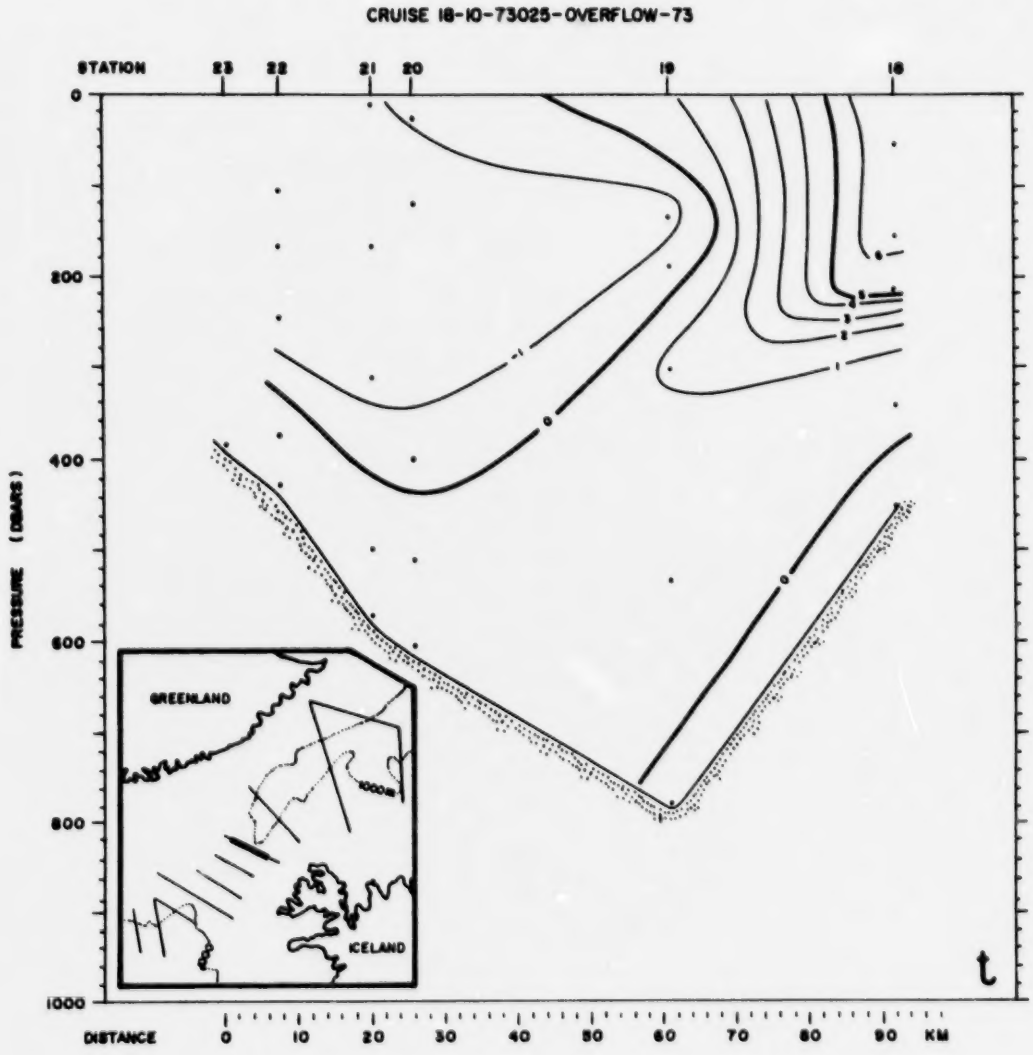



CRUISE 18-10-73025 - OVERFLOW 73
STATION 13 14 15 16 17
0
500
1000
1500
2000
2500
PRESSURE (DBARS)
GREENLAND
ICELAND
t
DISTANCE 0 10 20 30 40 50 60 70 KM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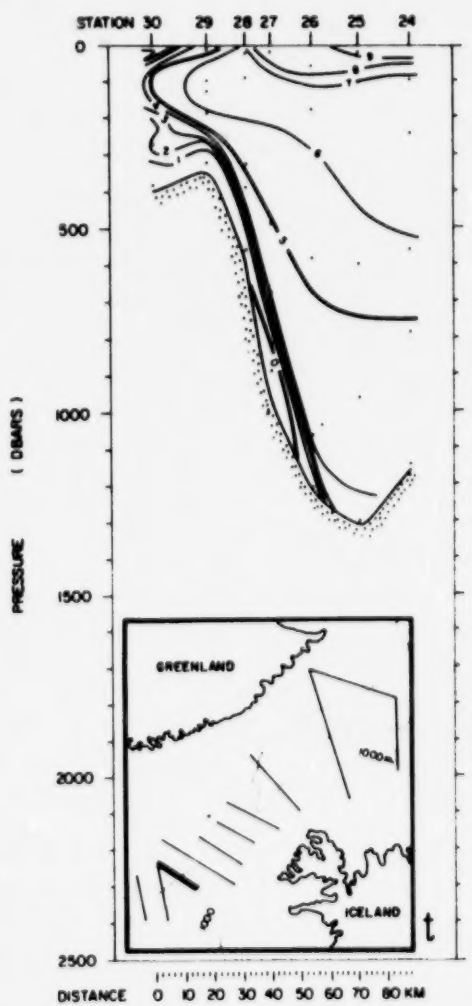
STATION 23 22 21 20 19 18
0
200
400
600
800
1000
PRESSURE (DBARS)
GREENLAND
ICELAND
t
DISTANCE 0 10 20 30 40 50 60 70 80 90 KM

CRUISE 18-10-73025- OVERFLOW 73



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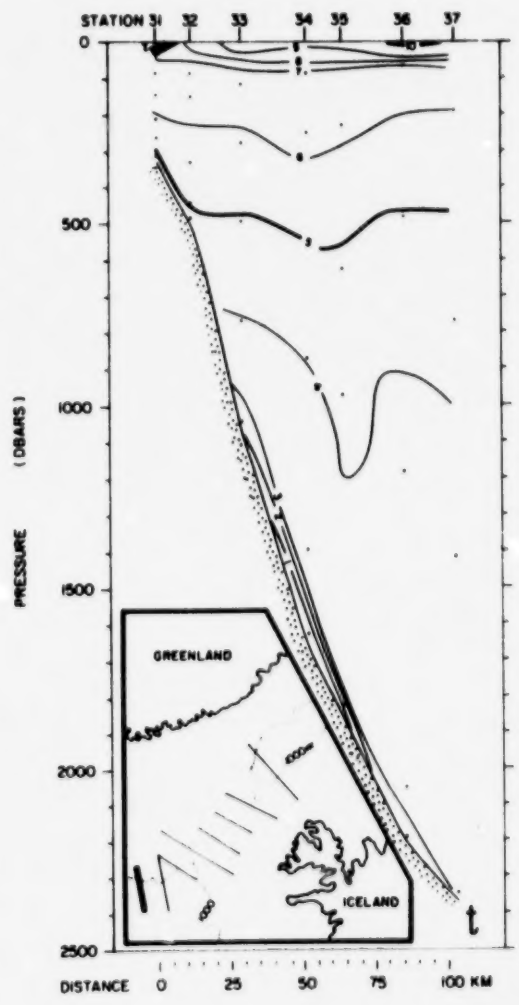

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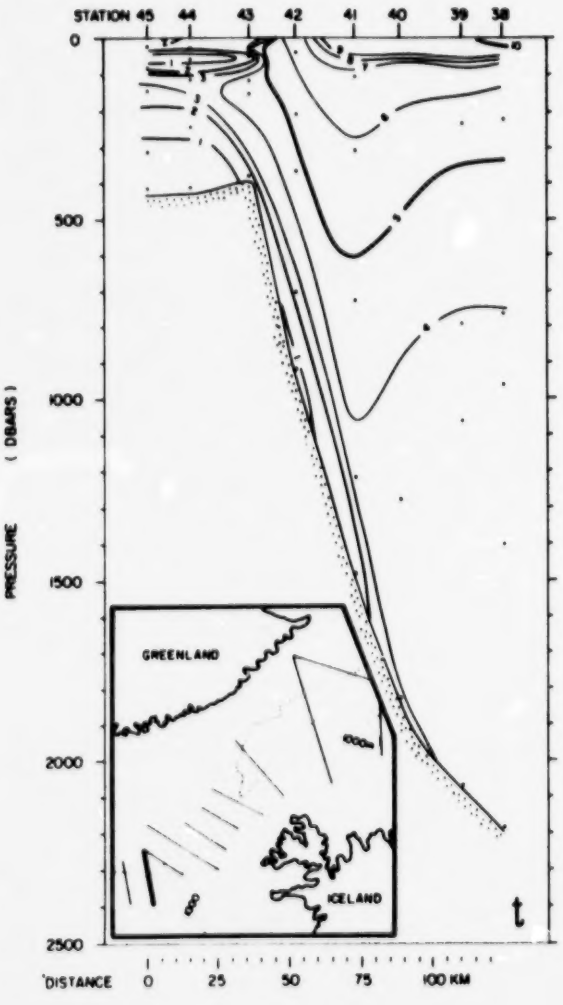

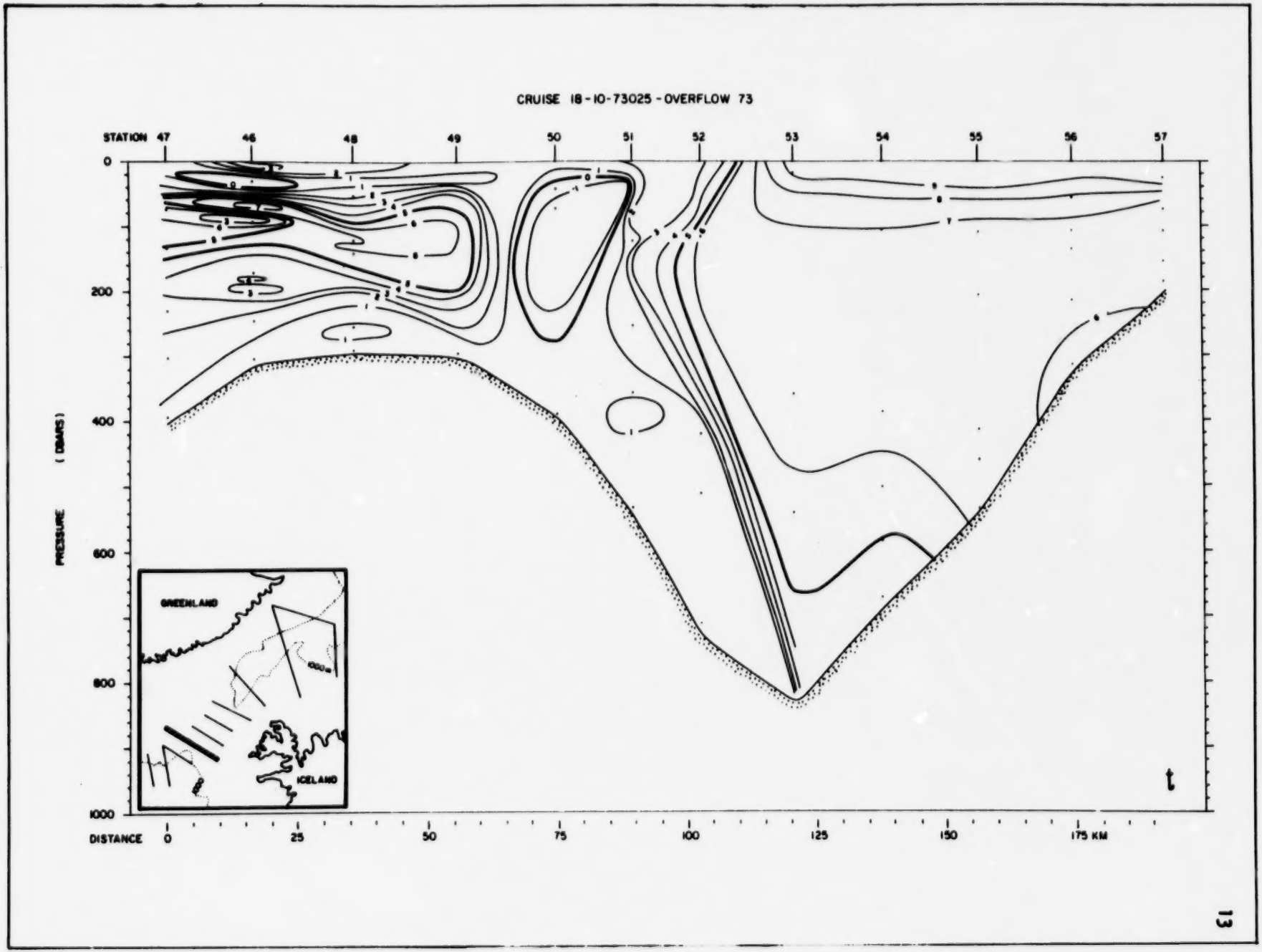
CRUISE 18-10-73025 - OVERFLOW 73
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200
400
600
800
1000
DISTANCE 0 25 50 75 100 125 150 175 KM
GREENLAND
ICELAND
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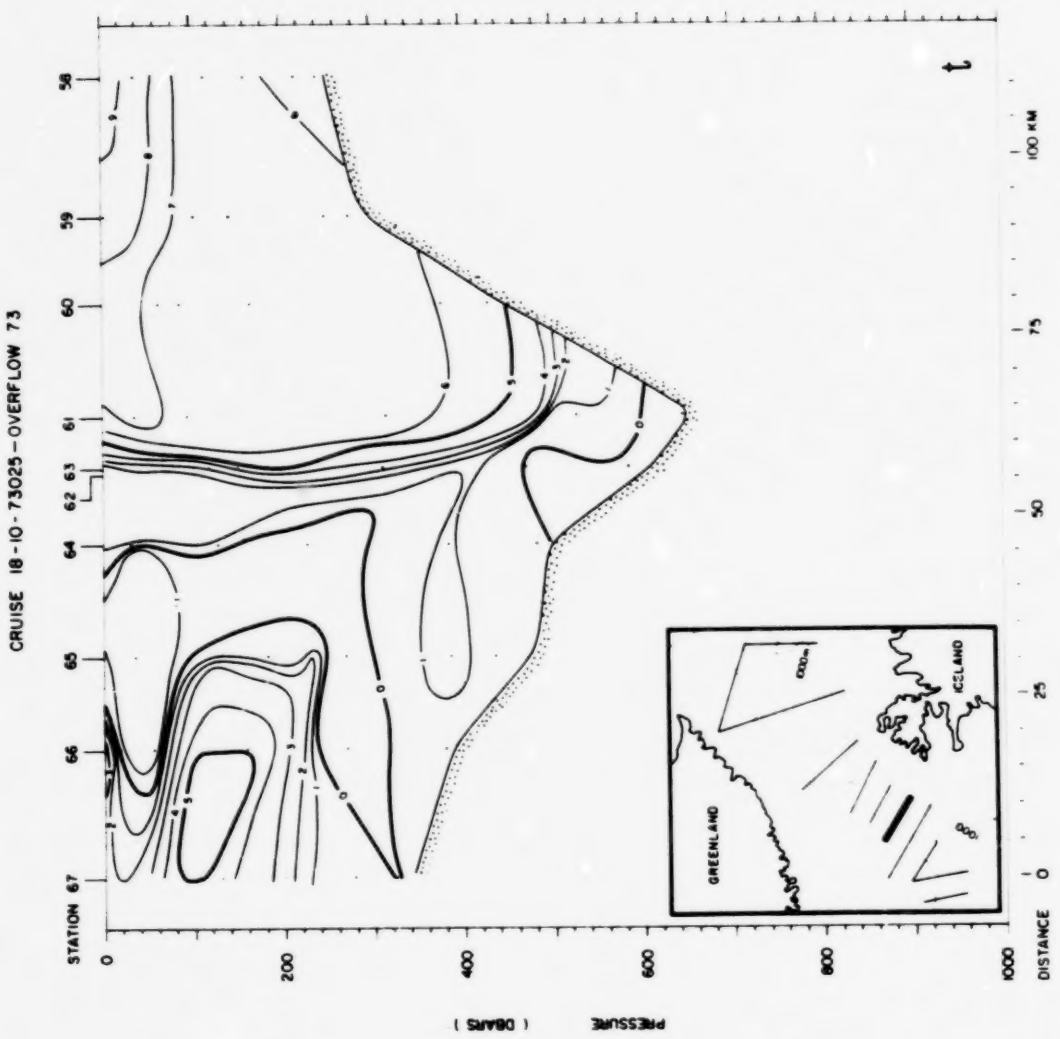
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STATION 67
58
59
60
61
62 63
64
65
66
67
0
200
400
600
800
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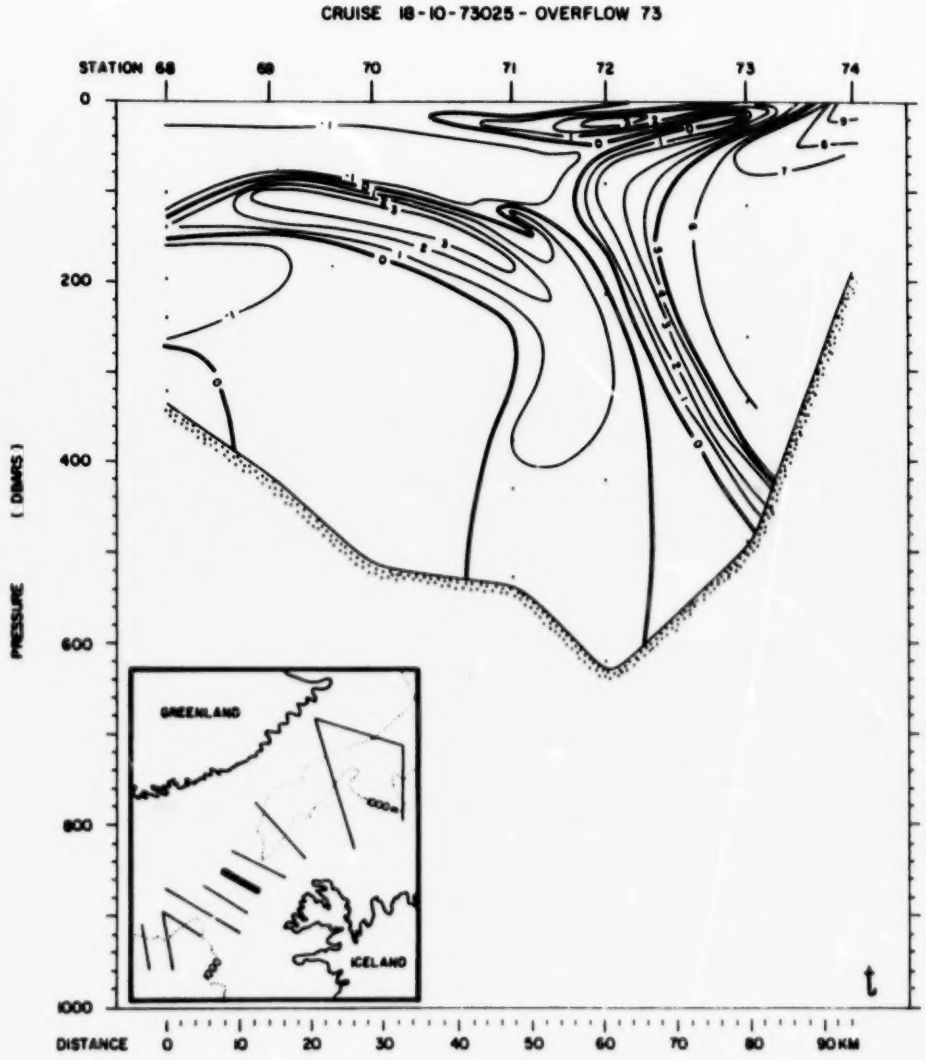
PRESSURE
(DBARS)
DISTANCE
0
25
50
75
100 KM
GREENLAND
ICELAND
1000m
2000m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200
400
600
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PRESSURE (DBARS)
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ICELAND
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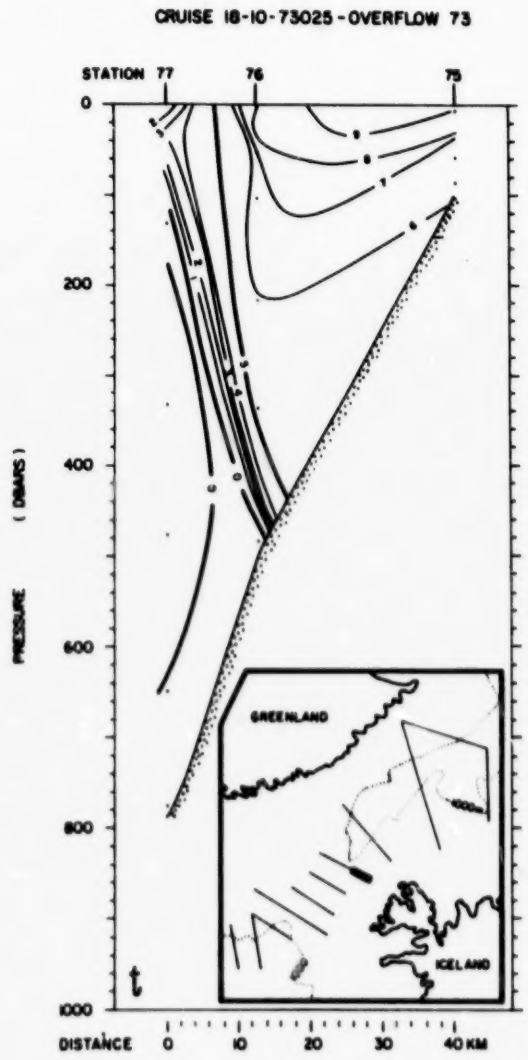
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600
800
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PRESSURE (DBARS)
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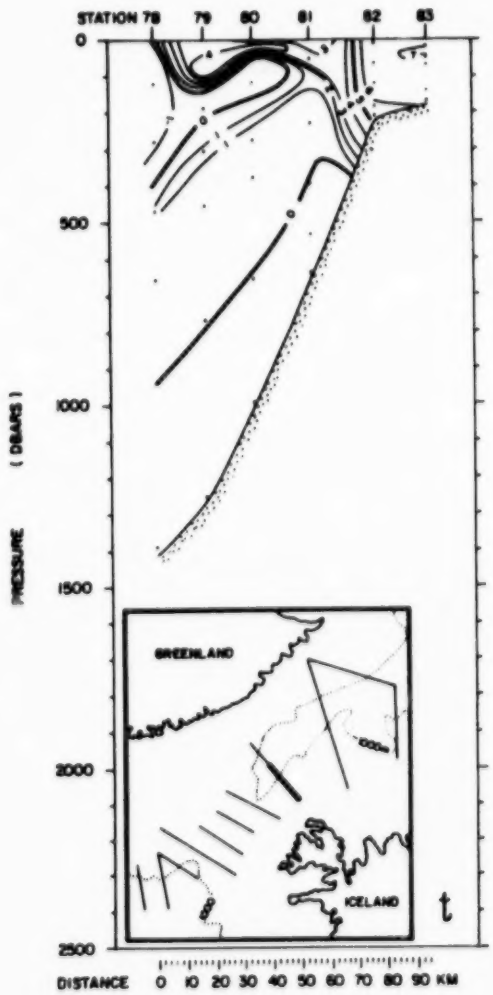
GREENLAND
ICELAND
t

CRUISE 18-10-73025 - OVERFLOW 73



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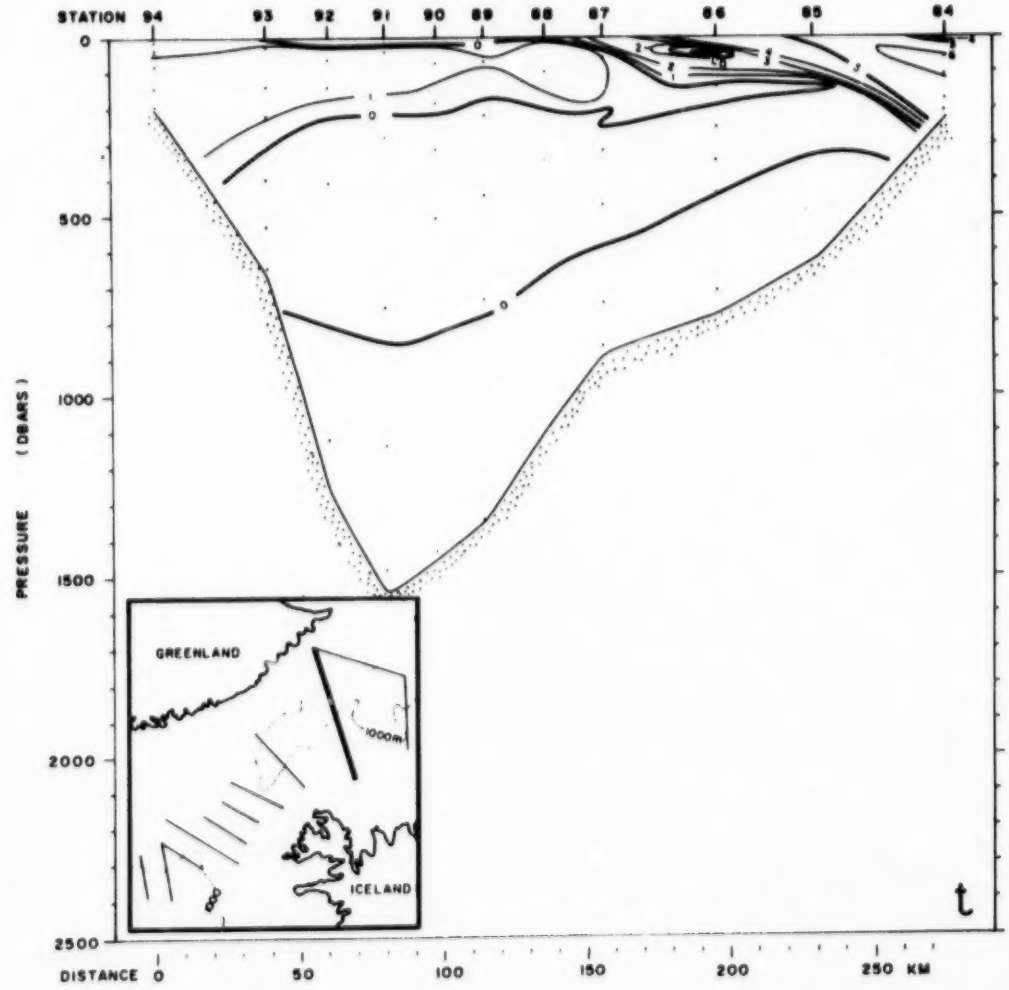

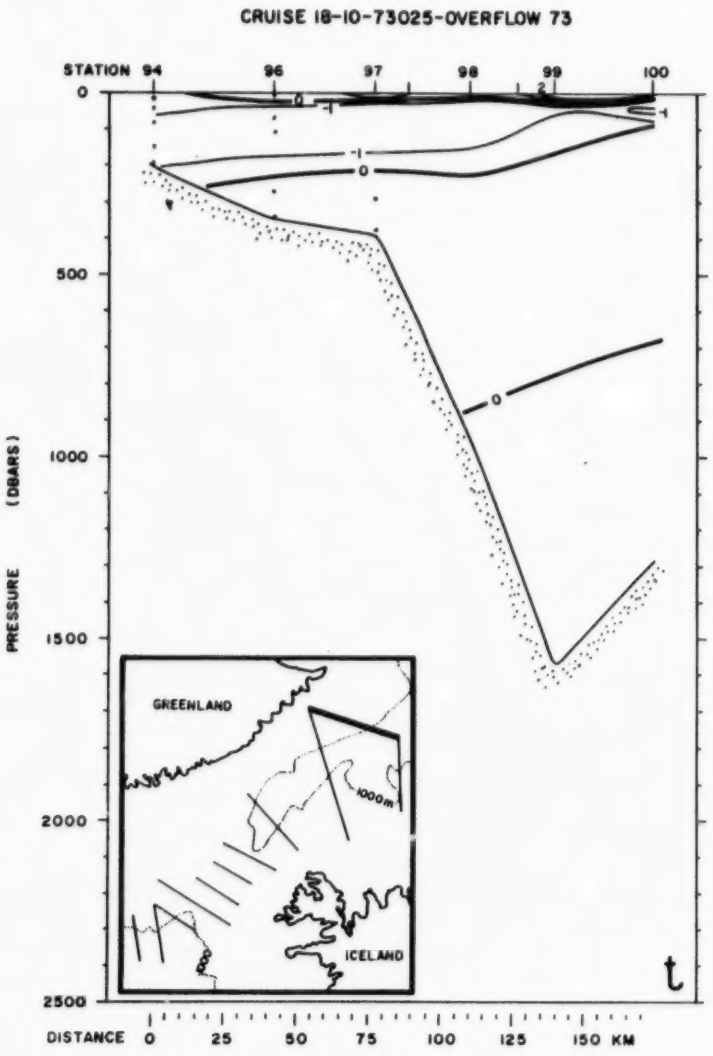
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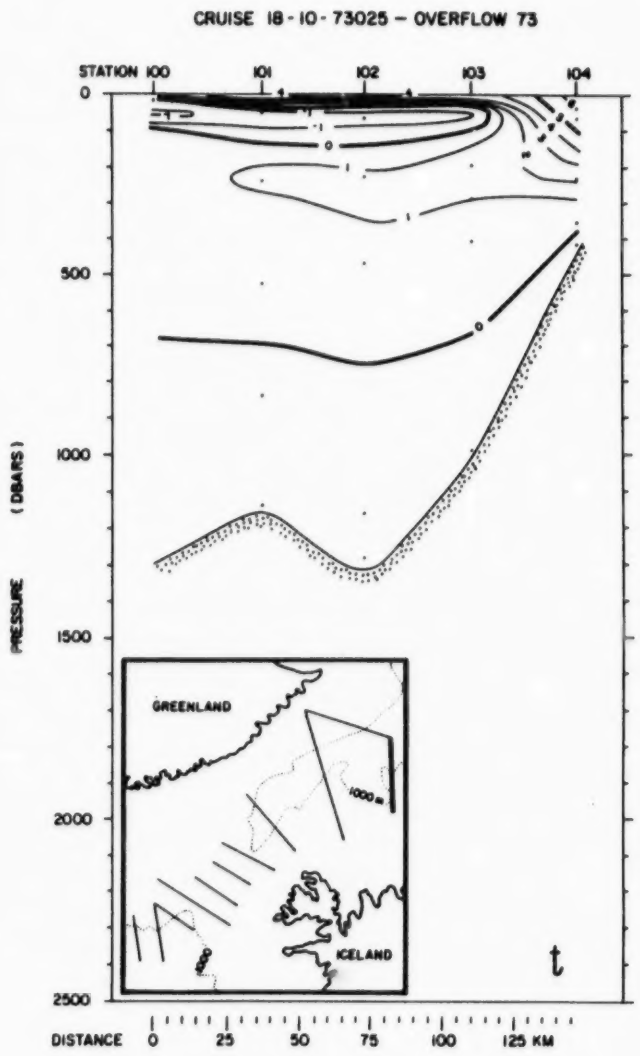
STATION 94
96
97
98
99
100
0
500
1000
1500
2000
2500
PRESSURE (DBARS)
DISTANCE 0 25 50 75 100 125 150 KM
GREENLAND
1000m
ICELAND
t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STATION 100
101
102
103
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1500
2000
2500
PRESSURE (DBARS)
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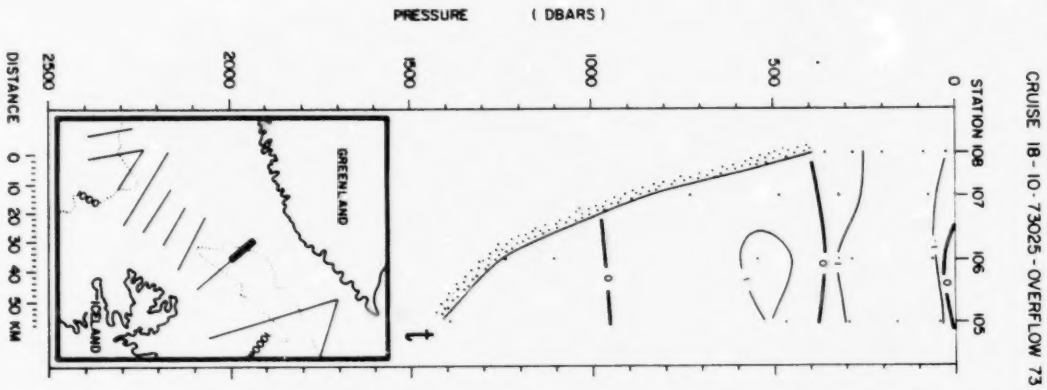
GREENLAND
1000m
ICELAND
t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2000
1500
1000
500
0
STATION 108 107 106 105
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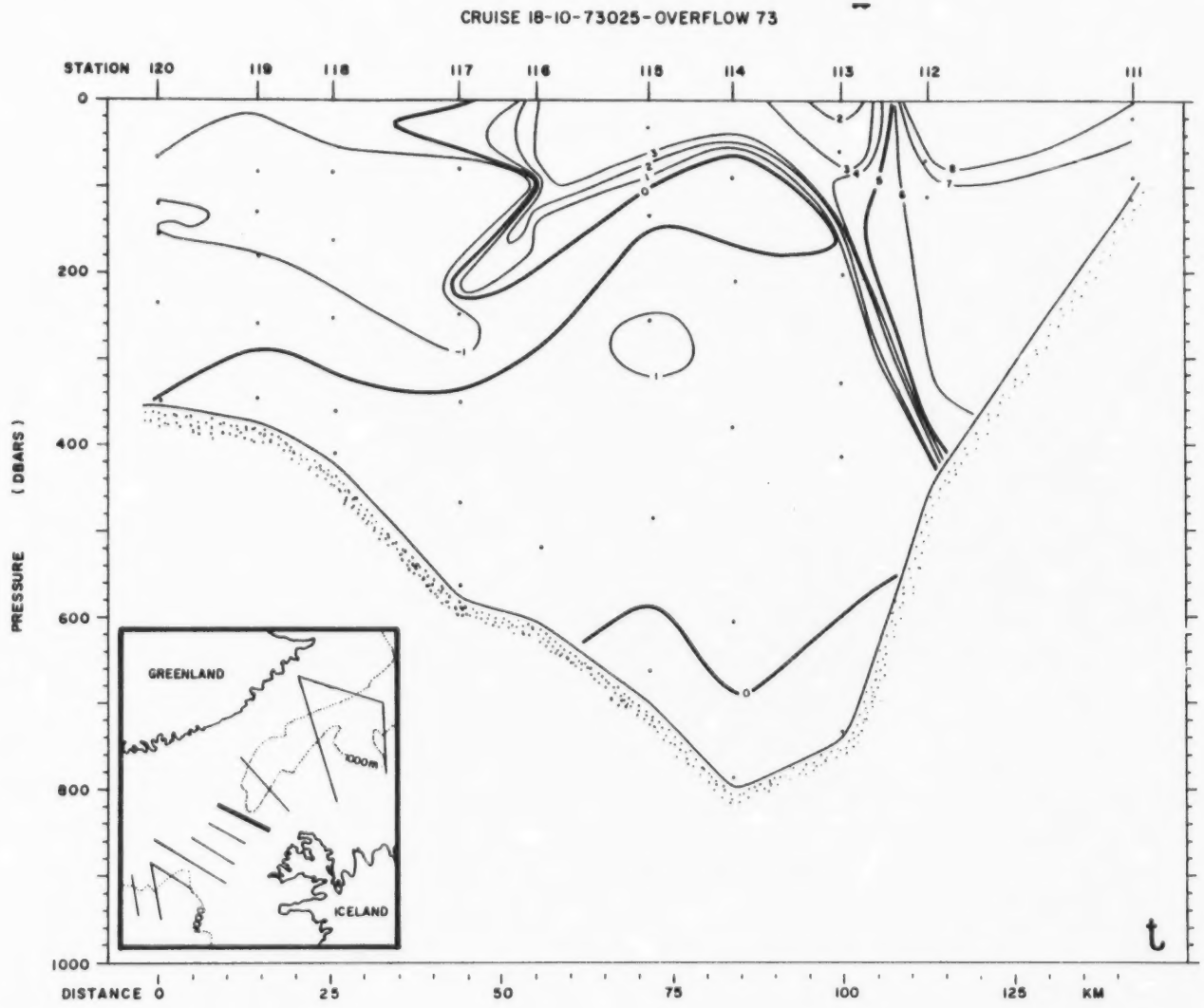
GREENLAND
ICELAND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200
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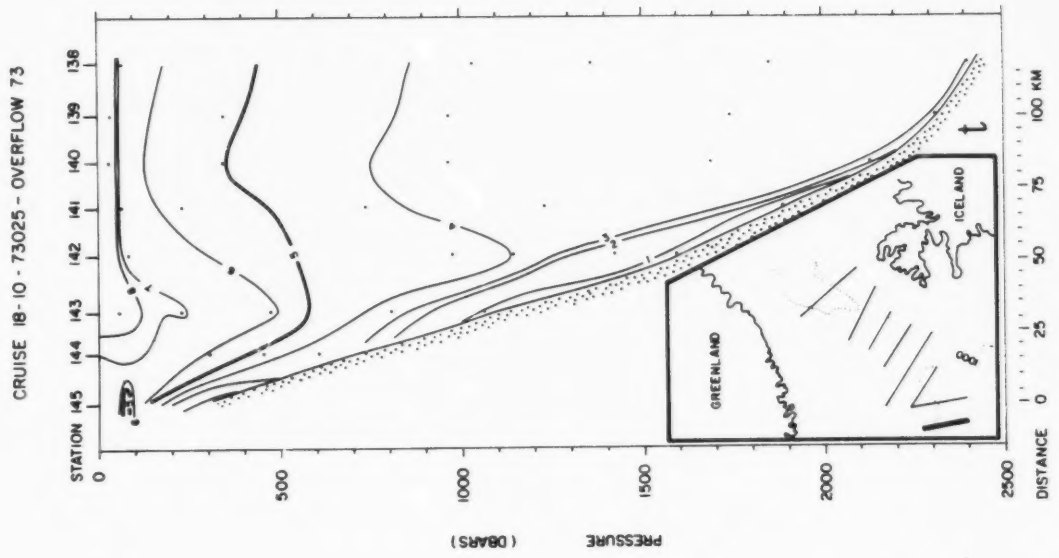
600
800
1000
DISTANCE 0 25 50 75 100 125 KM
GREENLAND
1000m
ICELAND
t


CRUISE 18-10-73025-OVERFLOW 73
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0
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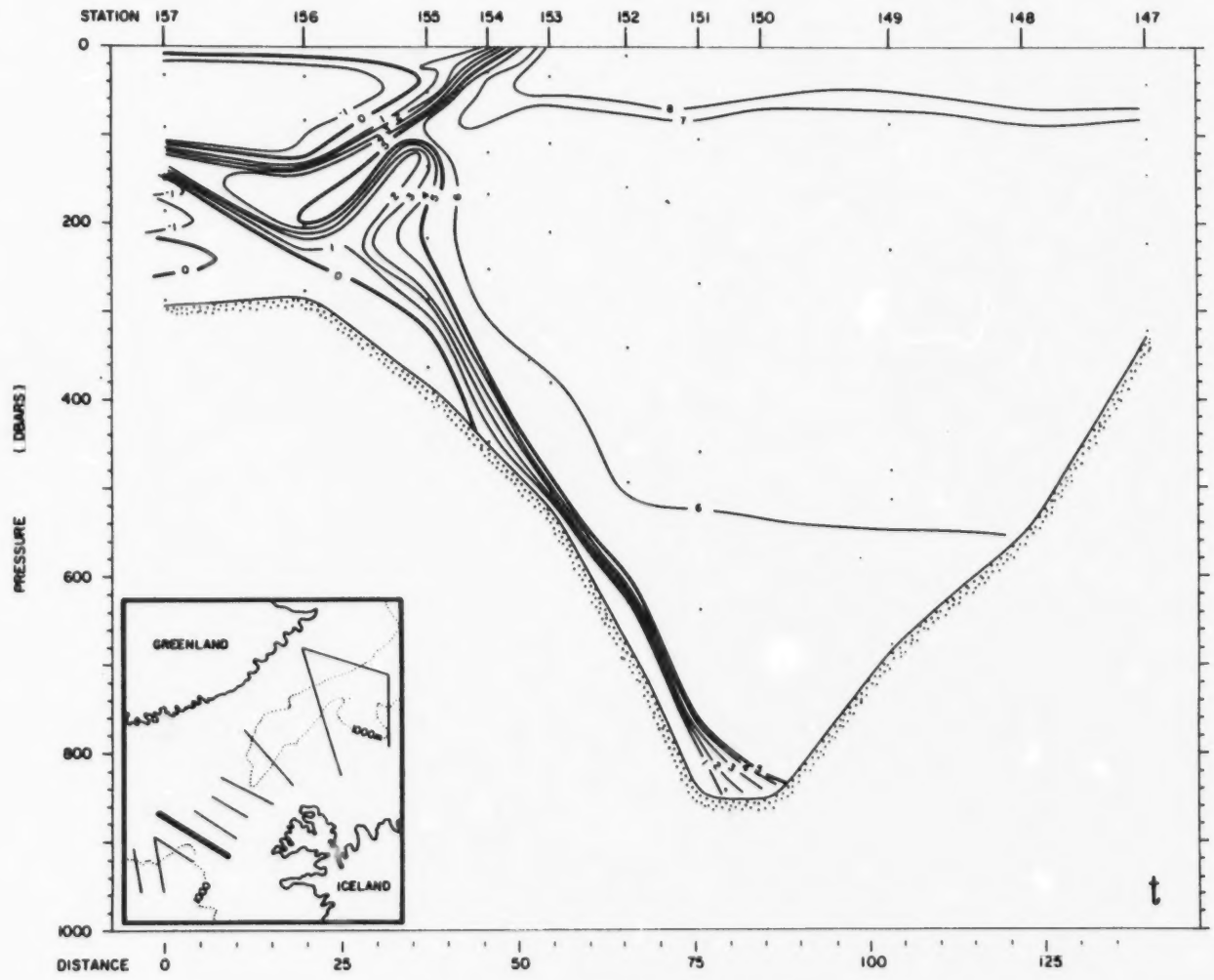
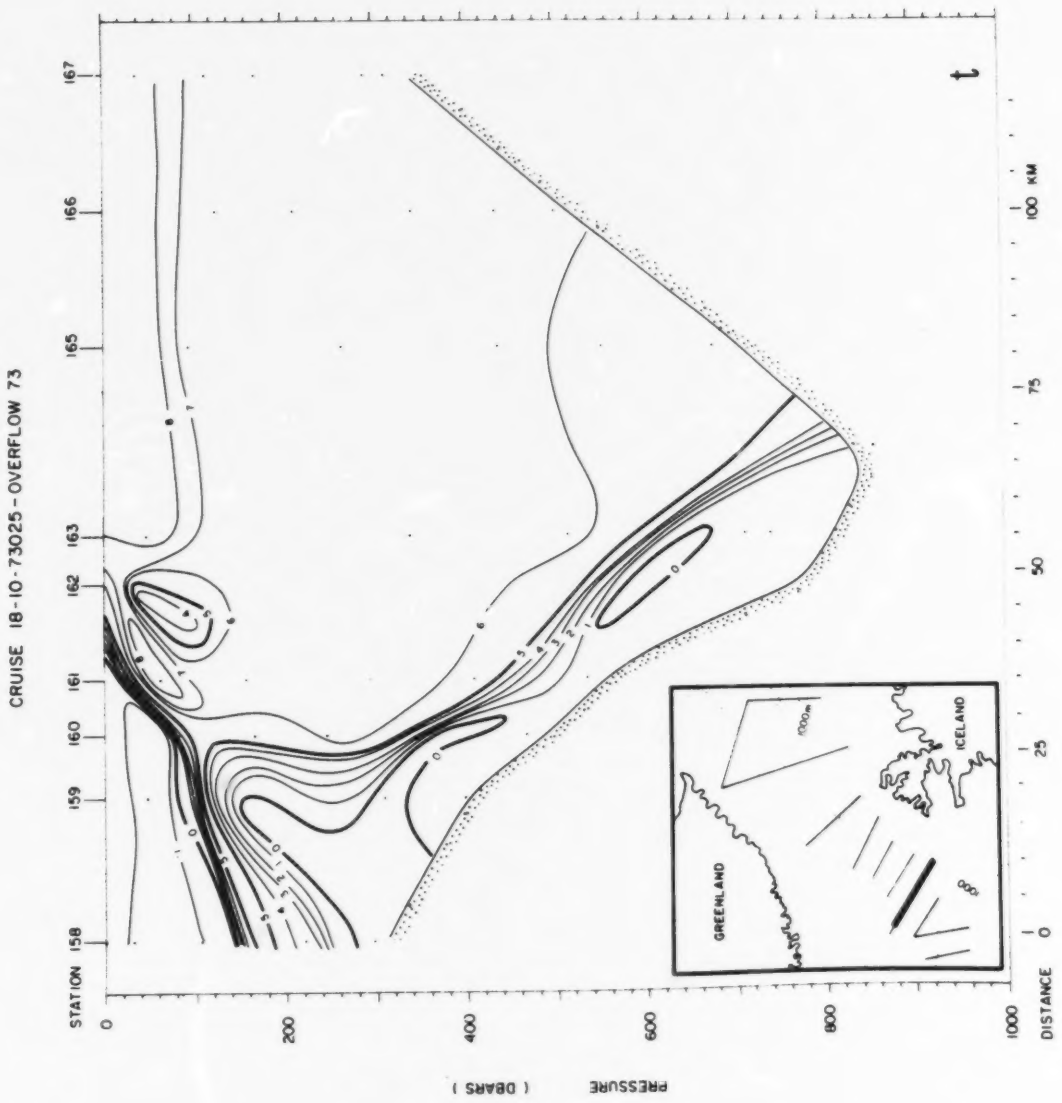
1000
1500
2000
2500
PRESSURE (DBARS)
DISTANCE 0 25 50 75 100 KM
GREENLAND
ICELAND

CRUISE 18-10-73025 - OVERFLOW 73




CRUISE 18-10-73025 - OVERFLOW 73
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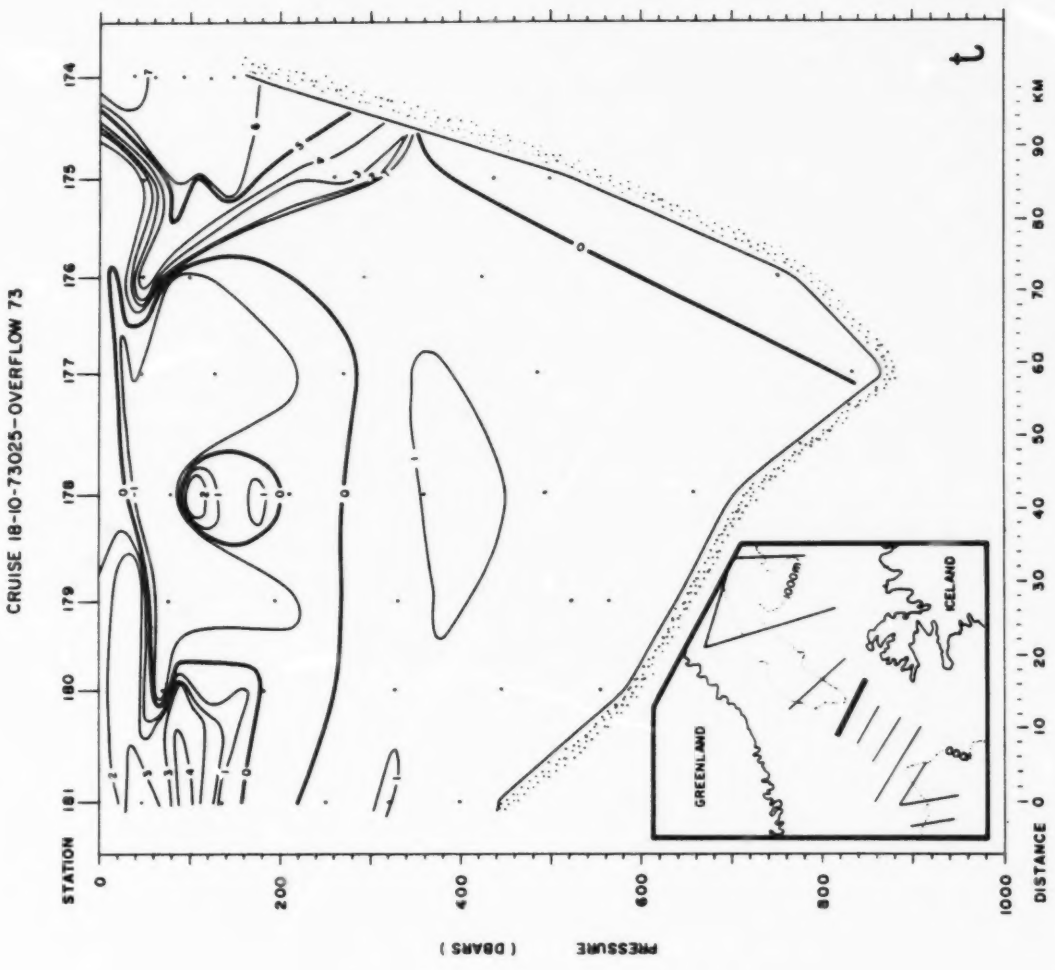
PRESSURE (DBARS)
DISTANCE 0 25 50 75 100 KM
GREENLAND
ICELAND
1000m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STATION
174
175
176
177
178
179
180
181
0
200
400
600
800
1000
PRESSURE
(DBARS)
DISTANCE
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10
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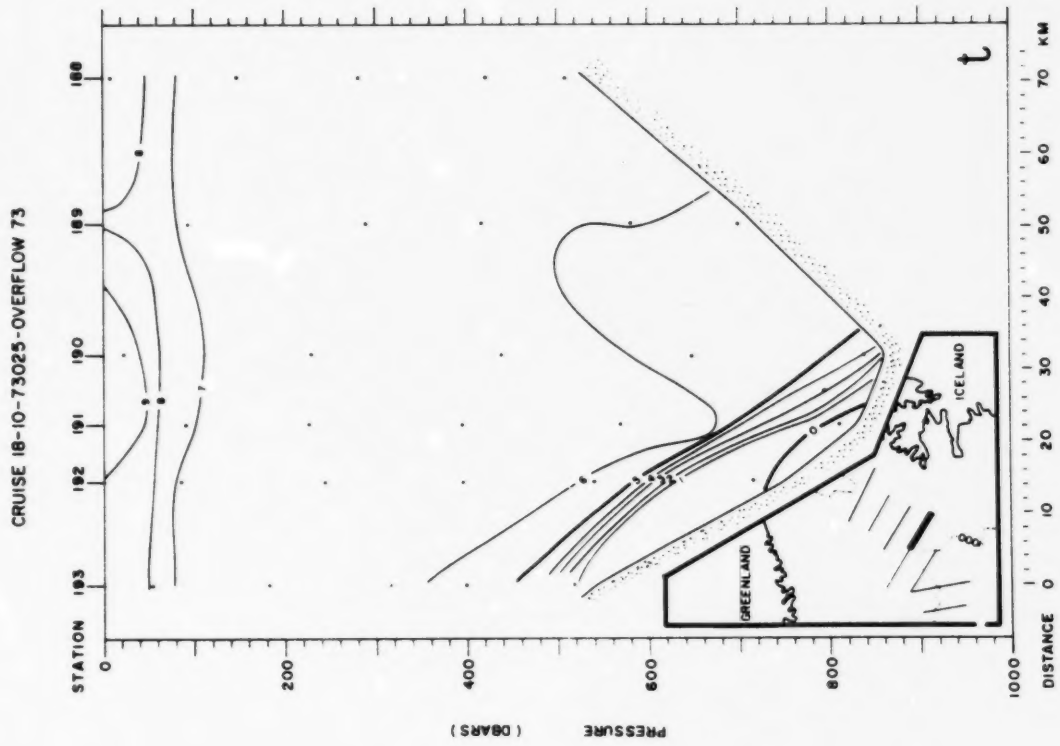
40
50
60
70
80
90
KM
GREENLAND
ICELAND
1000m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STATION 188 189 190 191 192 193
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200
400
600
800
1000
PRESSURE (DBARS)
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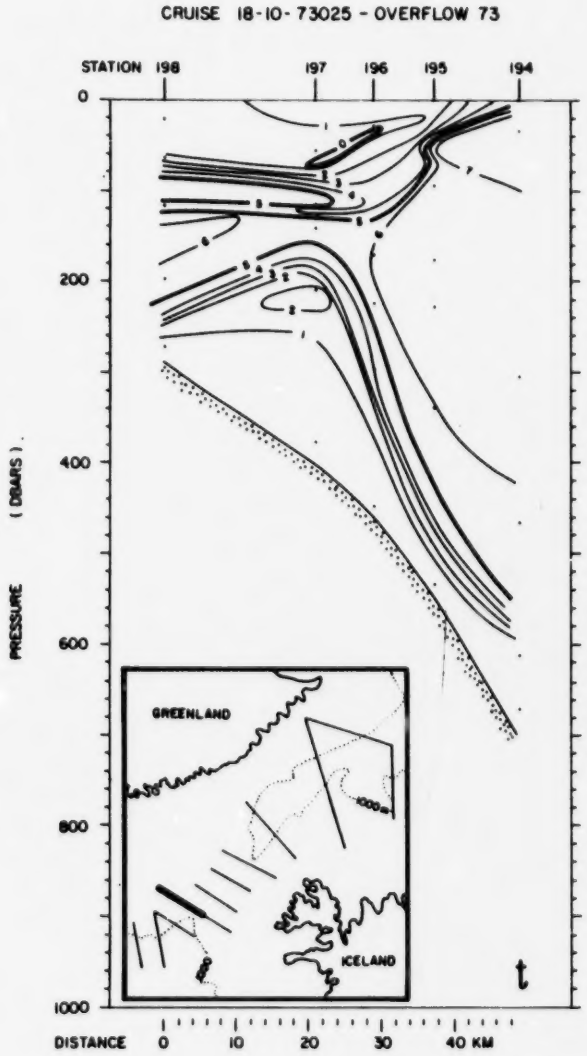
GREENLAND
ICELAND


CRUISE 18-10-73025 - OVERFLOW 73
STATION 198
197
196
195
194
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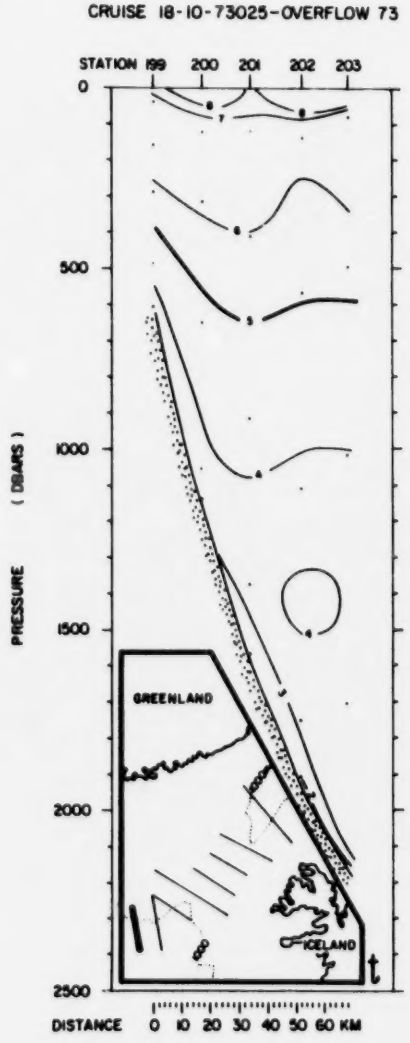
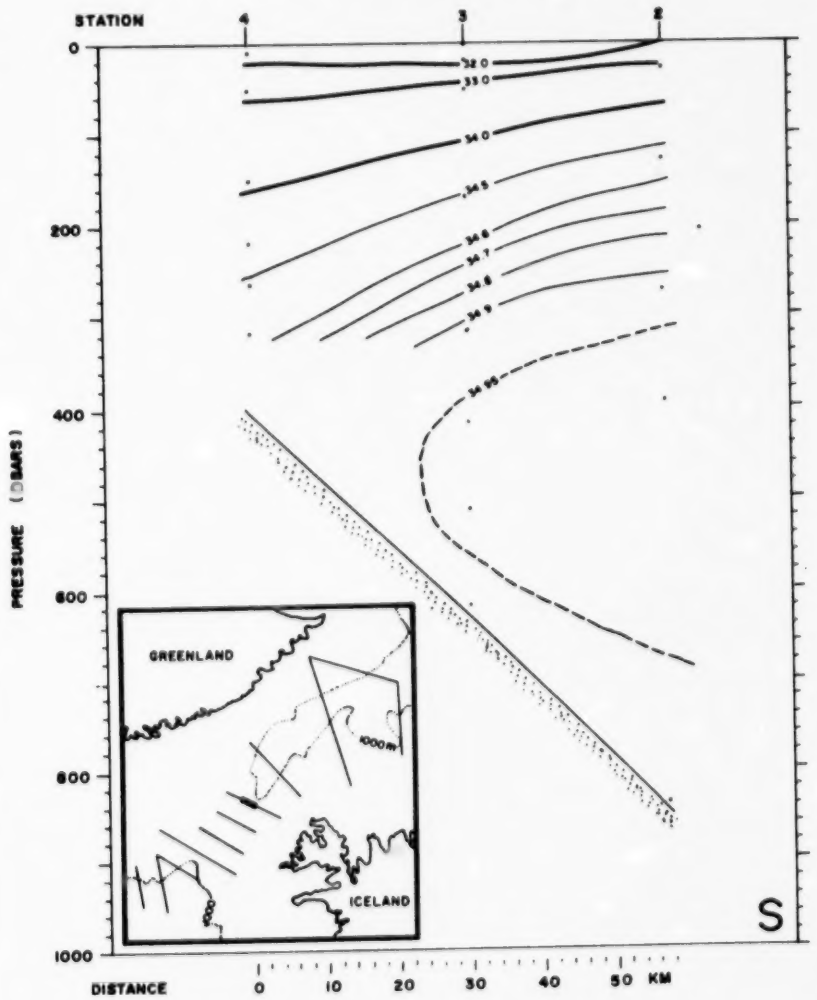
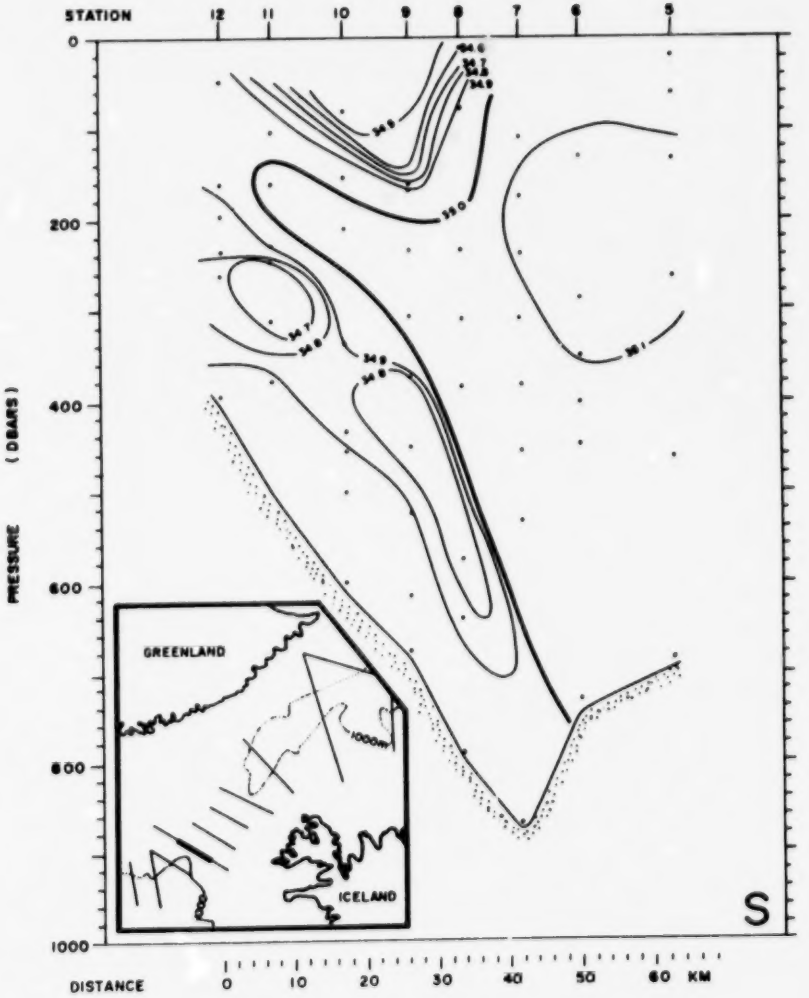
600
800
1000
PRESSURE (DBARS)
GREENLAND
ICELAND
DISTANCE 0 10 20 30 40 KM


CRUISE 18-10-73025-OVERFLOW 73
STATION 199
200
201
202
203
0
500
1000
1500
2000
2500
PRESSURE (DBARS)
GREENLAND
ICELAND
DISTANCE 0 10 20 30 40 50 60 KM

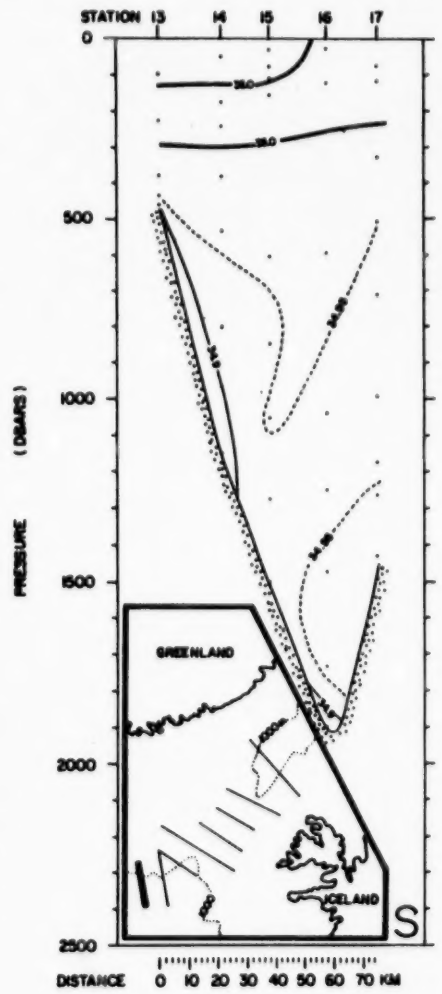
CRUISE 18-10-73025-OVERFLOW 73



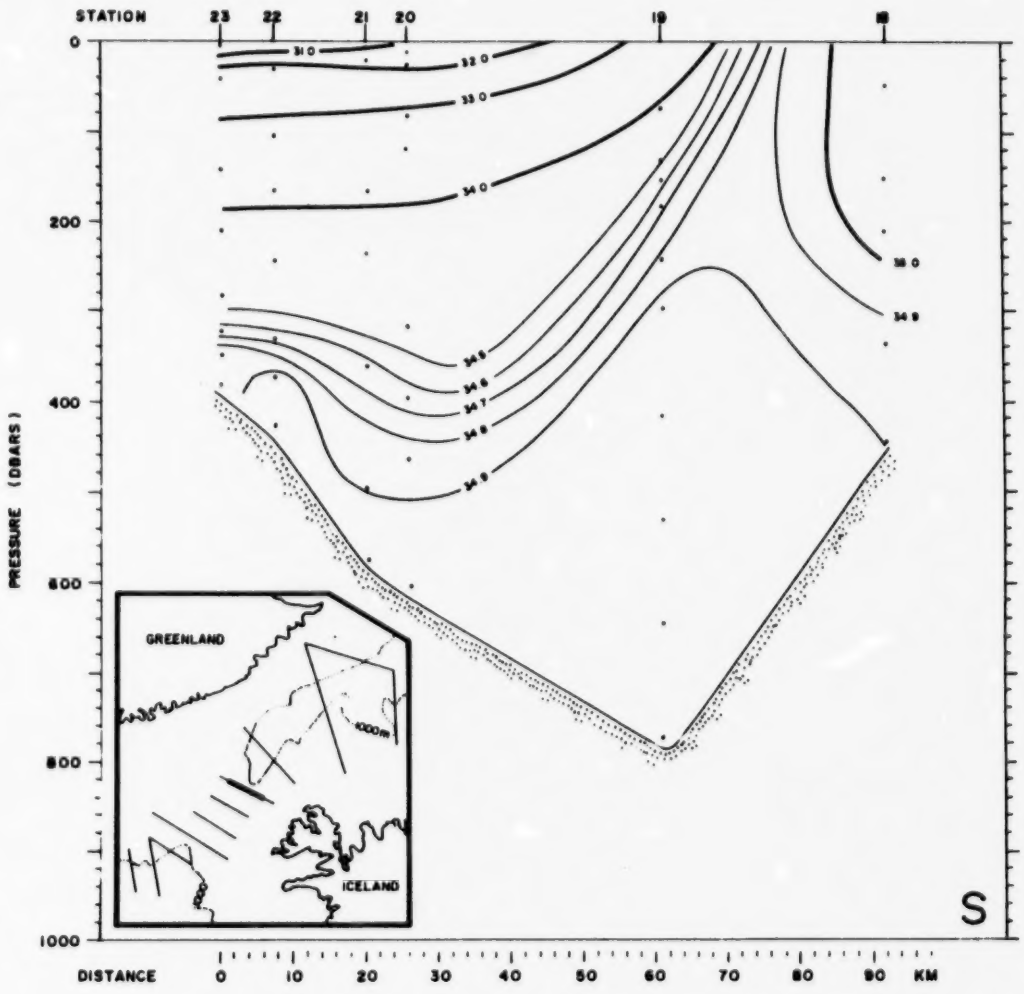
CRUISE 18-10-73025-OVERFLOW 73



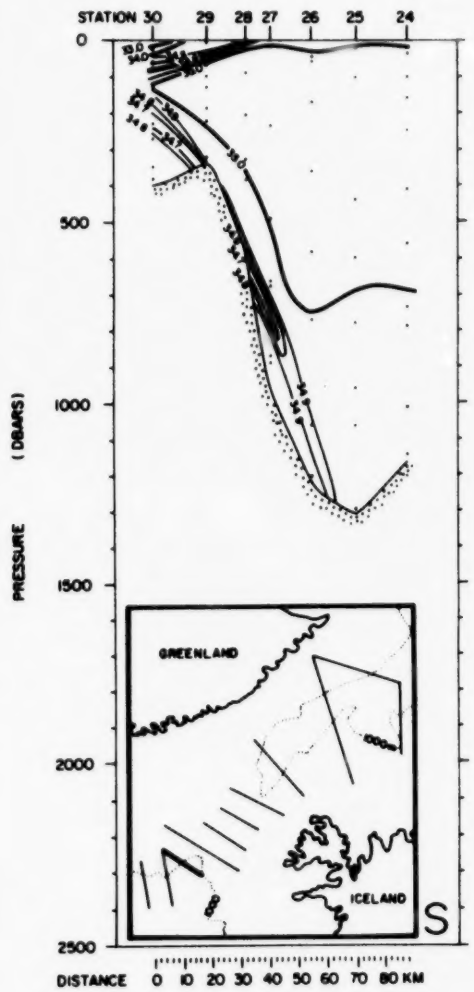
CRUISE 18-10-73025-OVERFLOW 73



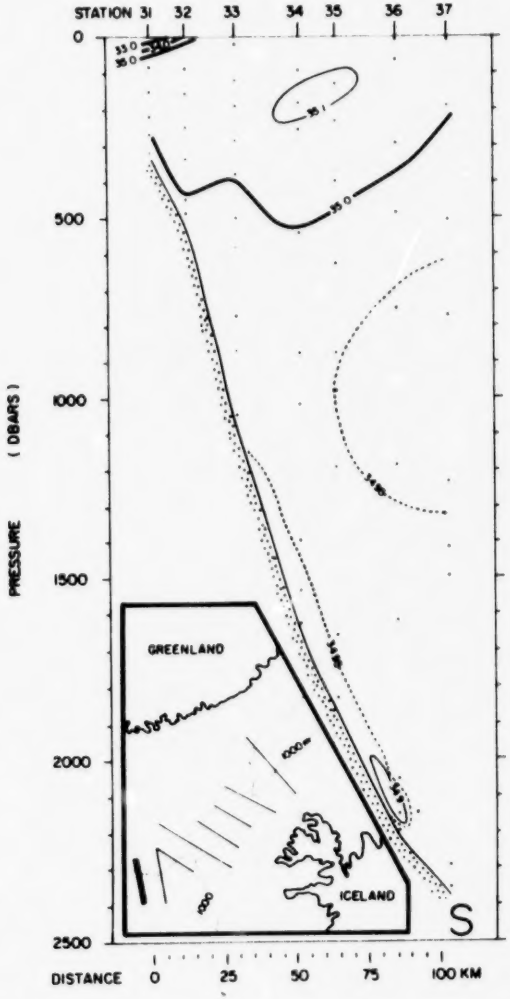
CRUISE 18-10-73025-OVERFLOW 73



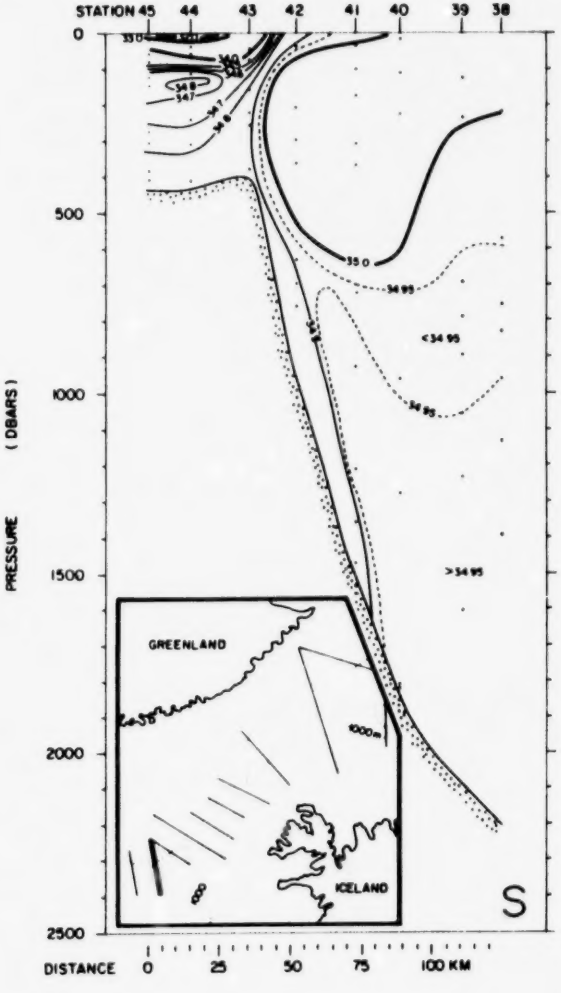
CRUISE 18-10-73025-OVERFLOW 73

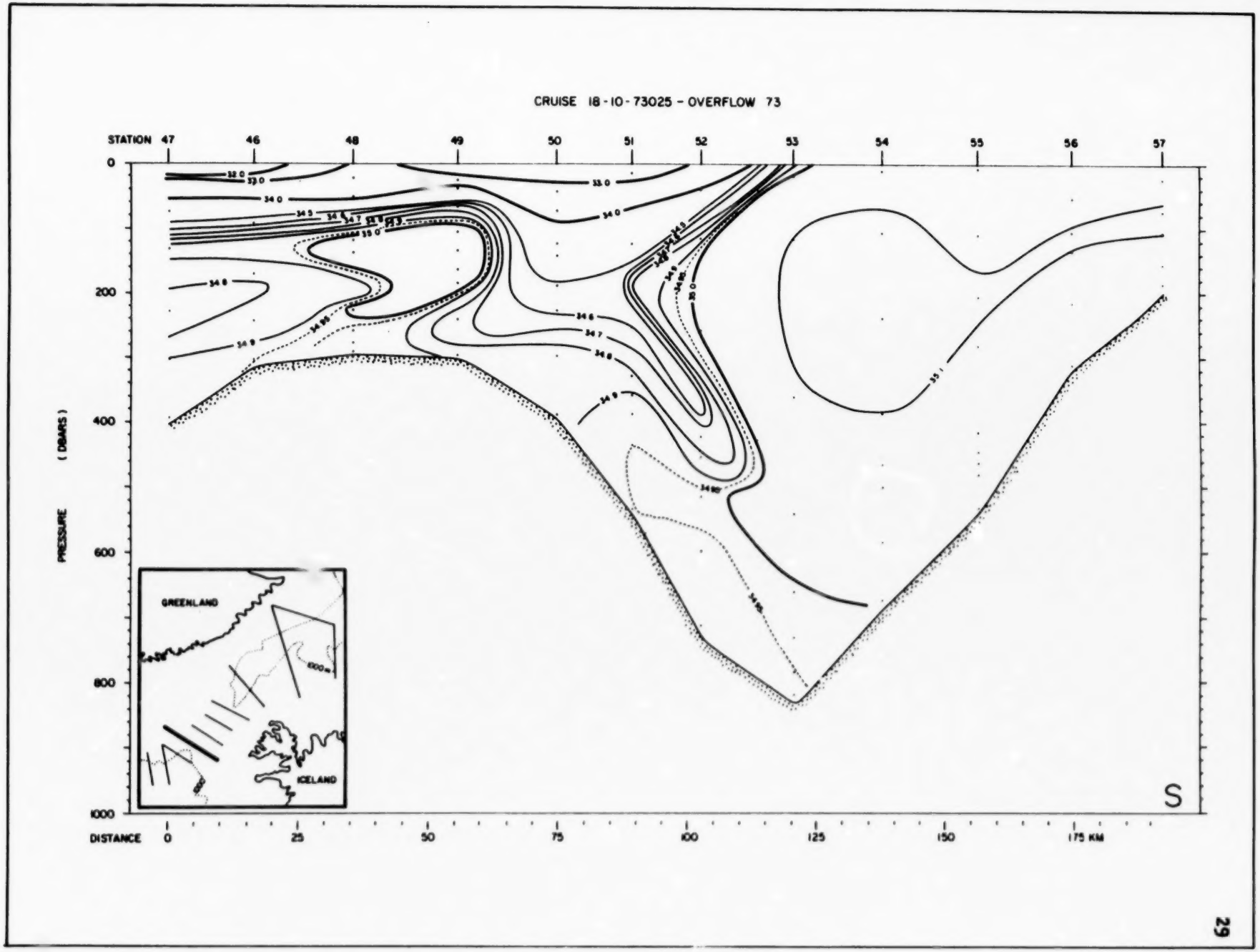


CRUISE 18-10-73025-OVERFLOW 73

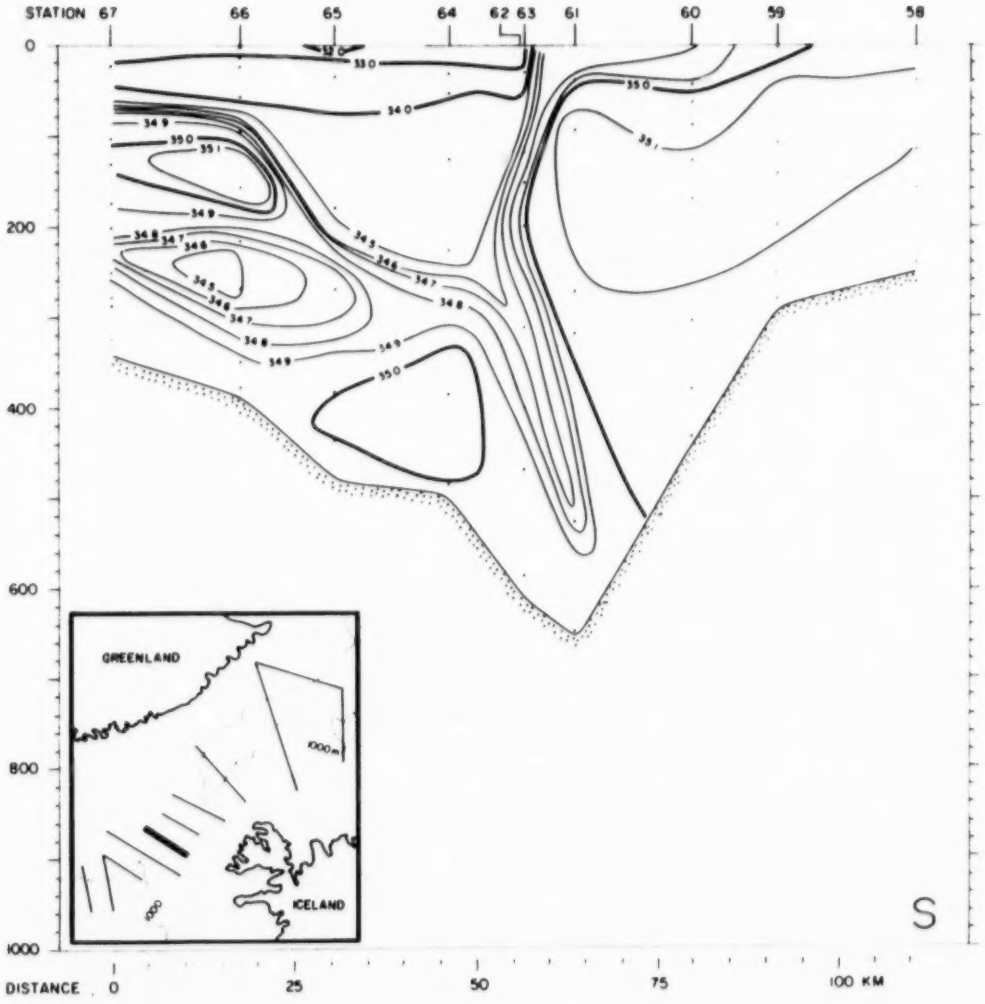


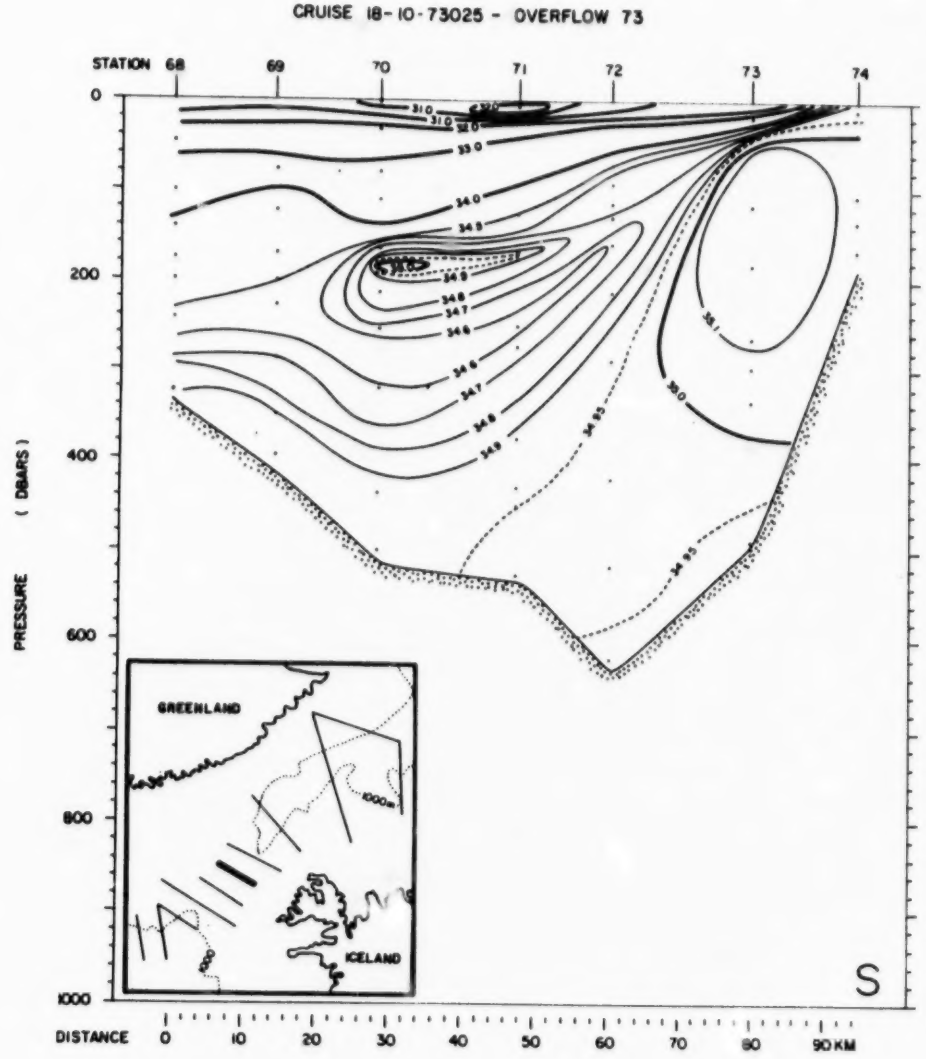
CRUISE 18-10-73025-OVERFLOW 73

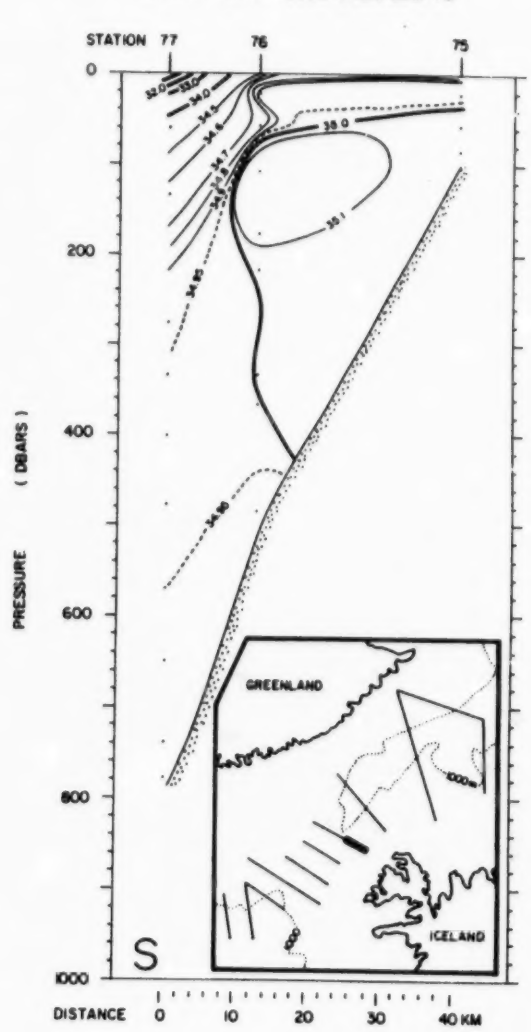



CRUISE 18-10-73025 - OVERFLOW 73
STATION 47 46 48 49 50 51 52 53 54 55 56 57
PRESSURE (DBARS)
0
200
400
600
800
1000
DISTANCE 0 25 50 75 100 125 150 175 KM
GREENLAND
ICELAND
S

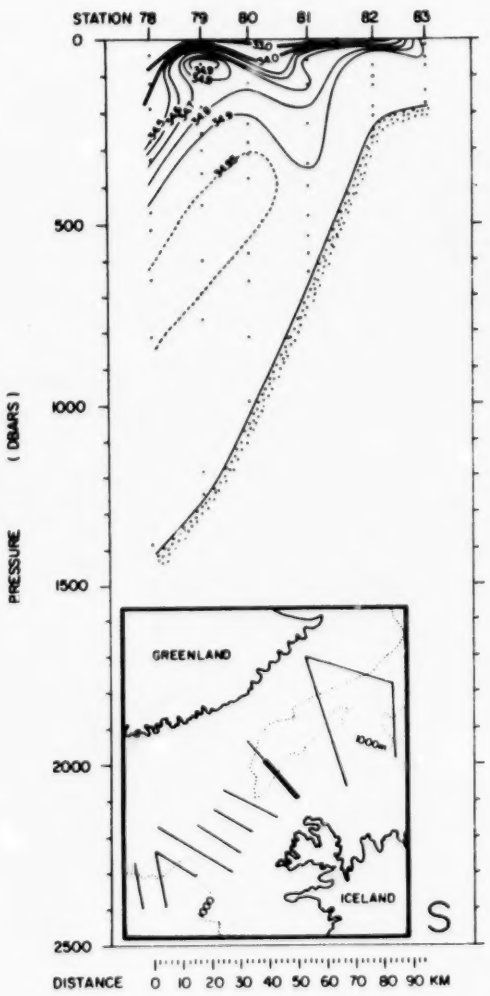
CRUISE 18-10-73025-OVERFLOW 73



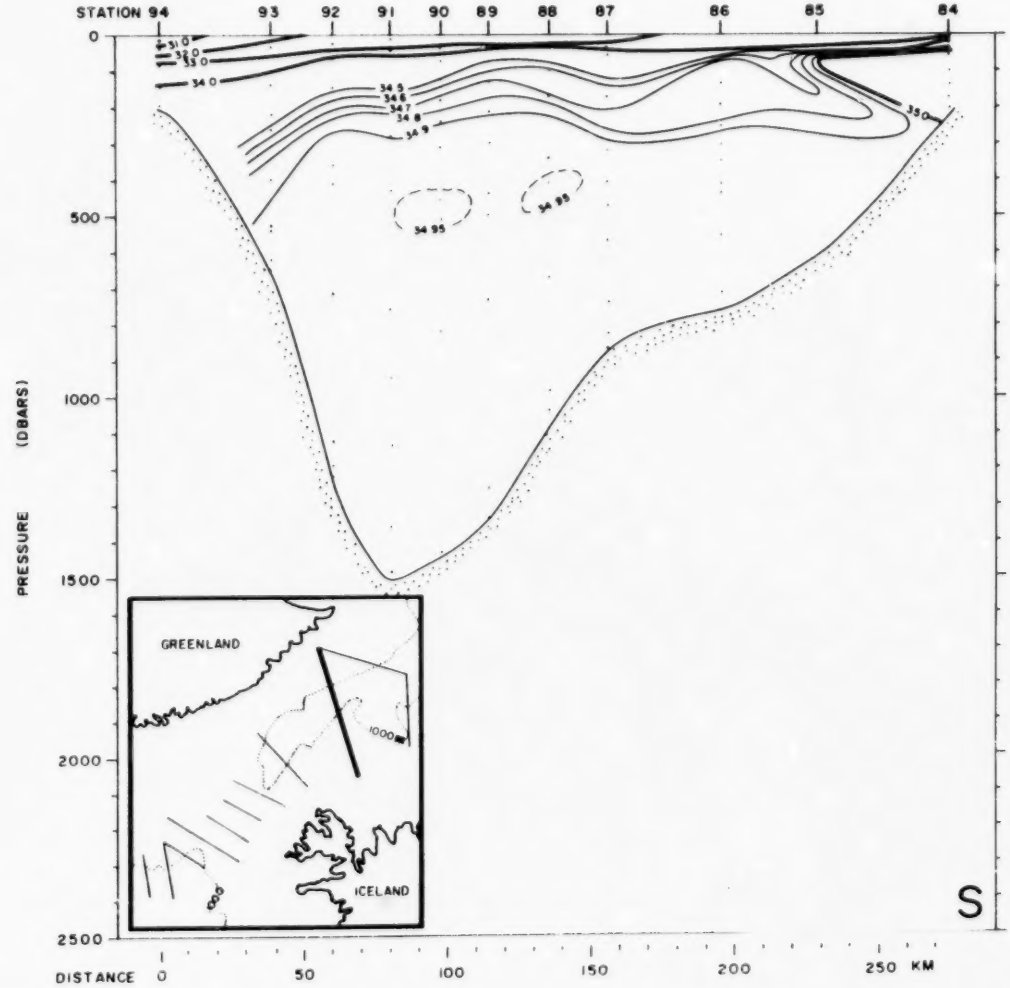

CRUISE 18-10-73025 - OVERFLOW 73
STATION 68 69 70 71 72 73 74
PRESSURE (DBARS)
DISTANCE 0 10 20 30 40 50 60 70 80 90 KM
GREENLAND
ICELAND
S

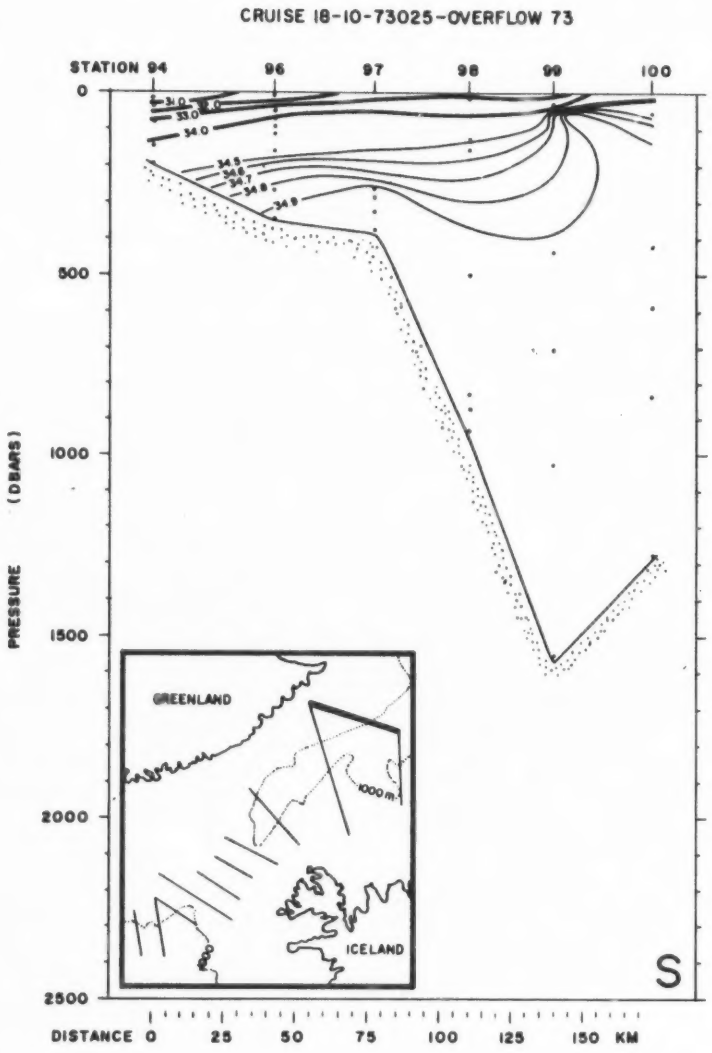

CRUISE 18-10-73025-OVERFLOW 73
STATION 77 76 75
PRESSURE (DBARS)
DISTANCE 0 10 20 30 40 KM
GREENLAND
ICELAND
S

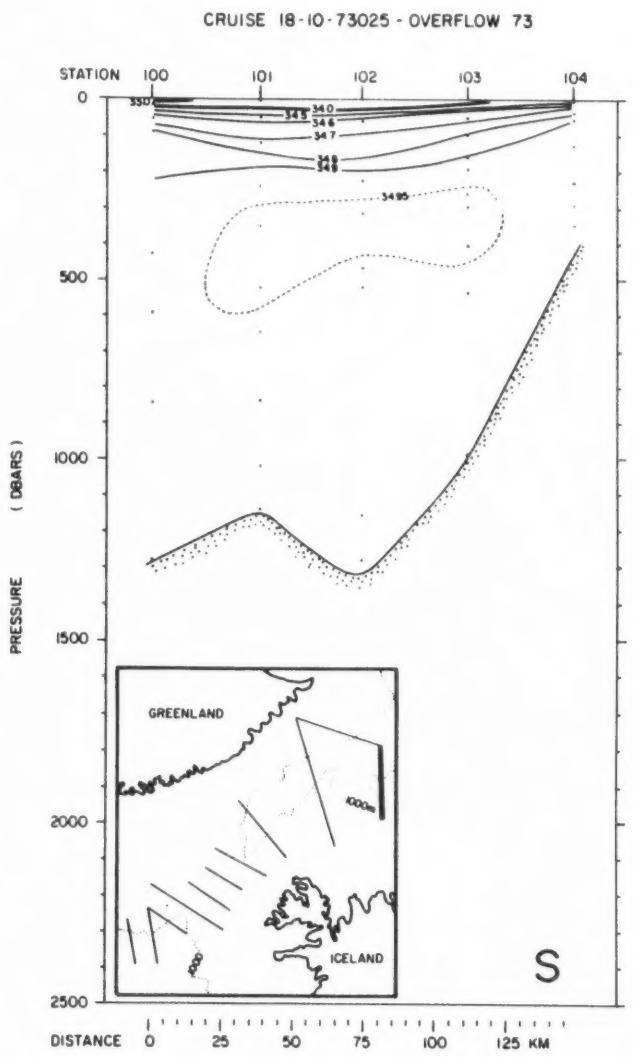
CRUISE 18-10-73025 - OVERFLOW 73

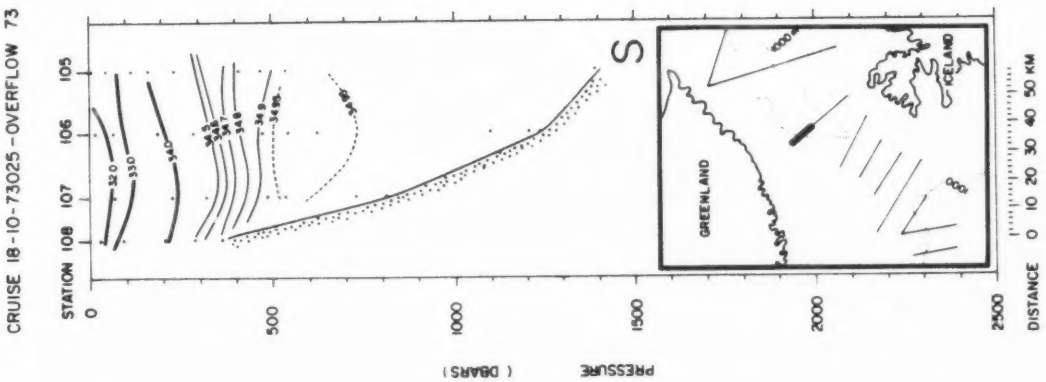


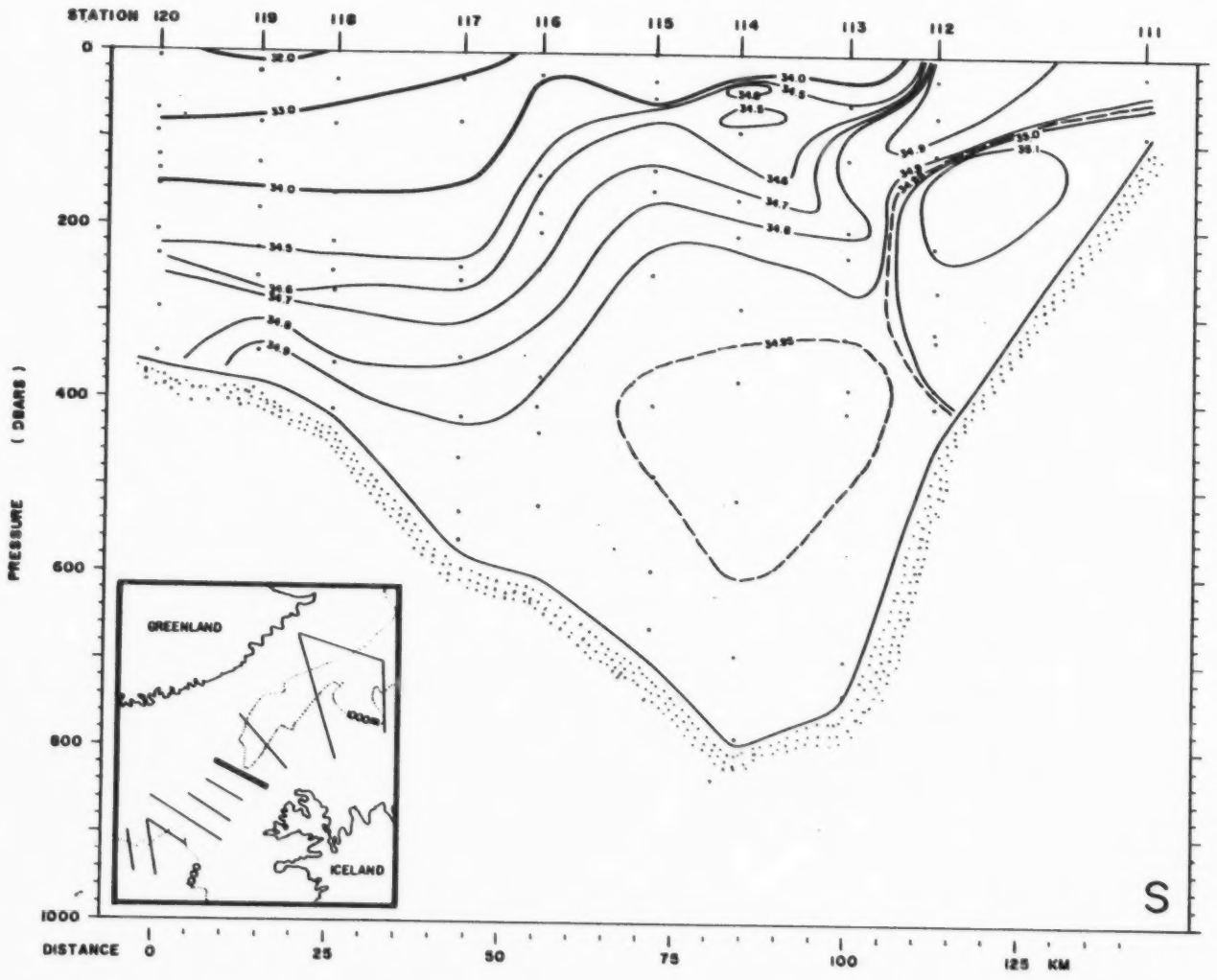
CRUISE 18-10-73025-OVERFLOW 73

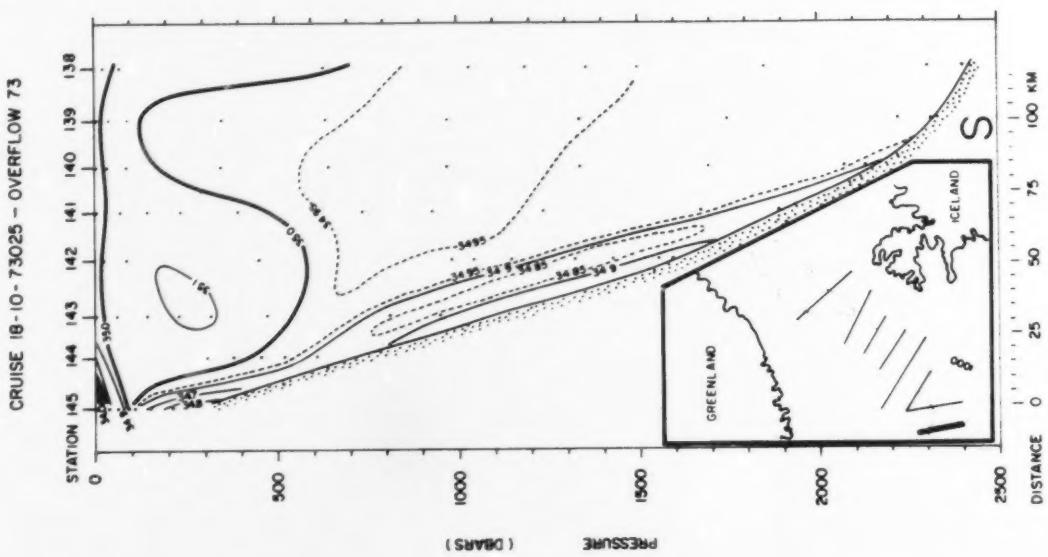


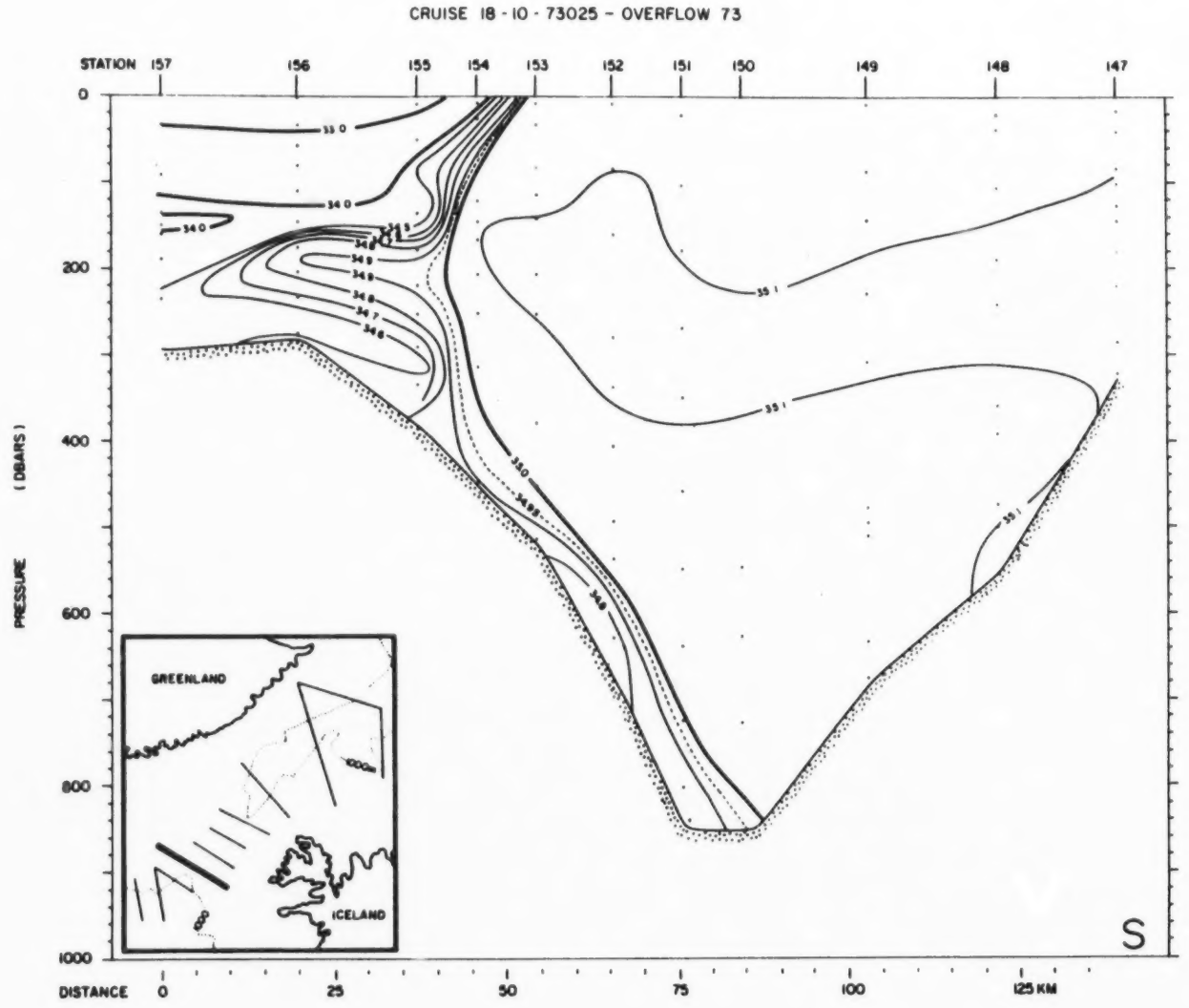

CRUISE 18-10-73025-OVERFLOW 73
STATION 94
96
97
98
99
100
0
500
1000
1500
2000
2500
PRESSURE (DBARS)
34.0
34.5
34.6
34.7
34.8
34.9
GREENLAND
1000 m
ICELAND
S
DISTANCE 0
25
50
75
100
125
150 KM


CRUISE 18-10-73025 - OVERFLOW 73
STATION 100
101
102
103
104
0
500
1000
1500
2000
2500
PRESSURE (DBARS)
34.0
34.5
34.6
34.7
34.8
34.95
GREENLAND
ICELAND
S
DISTANCE 0
25
50
75
100
125 KM

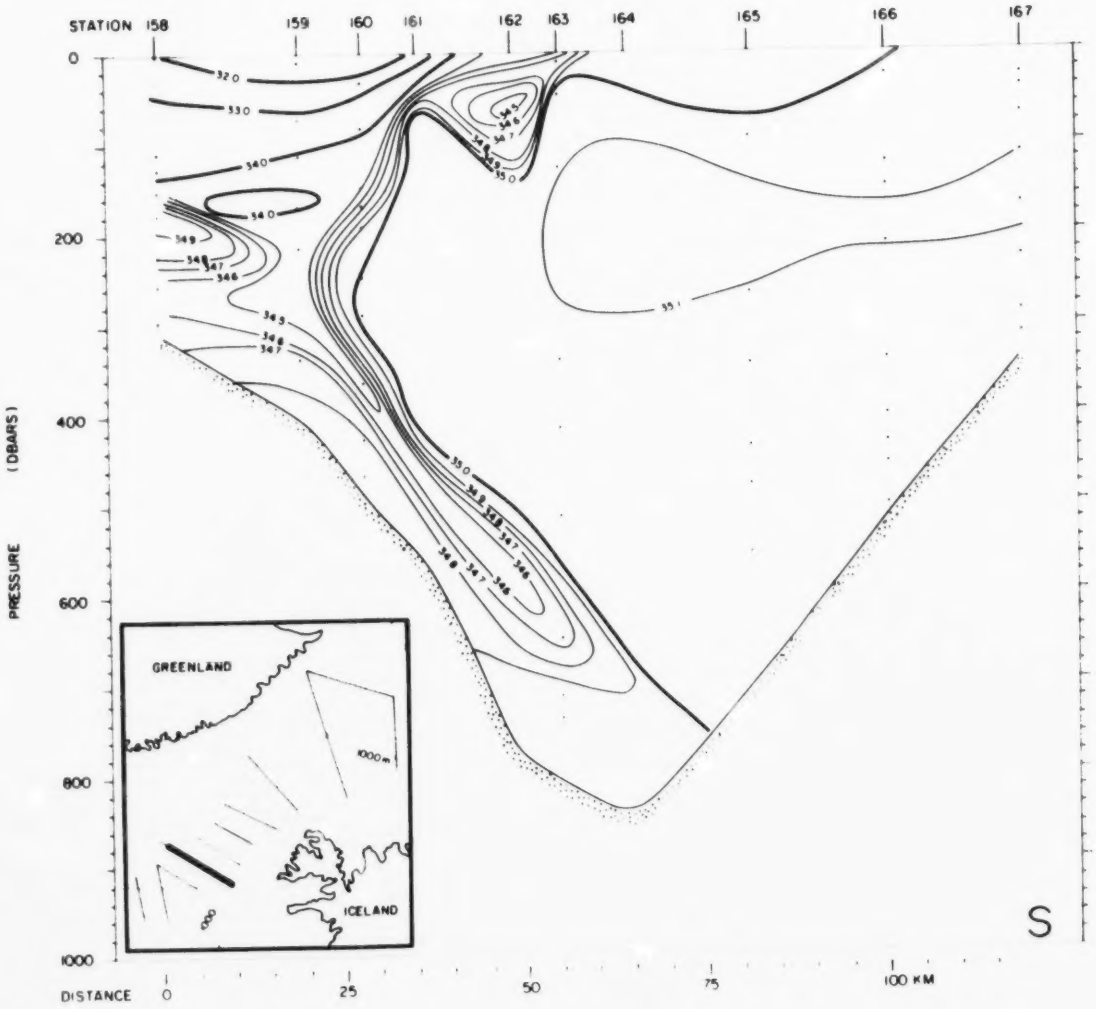

CRUISE 18-10-73025-OVERFLOW 73
STATION 108 107 106 105
0
500
1000
1500
2000
2500
PRESSURE (DBARS)
DISTANCE 0 10 20 30 40 50 KM
S
GREENLAND
ICELAND
1000
2000
3000
3200
3300
3400
3450
3475
3480
3485
3490
3495

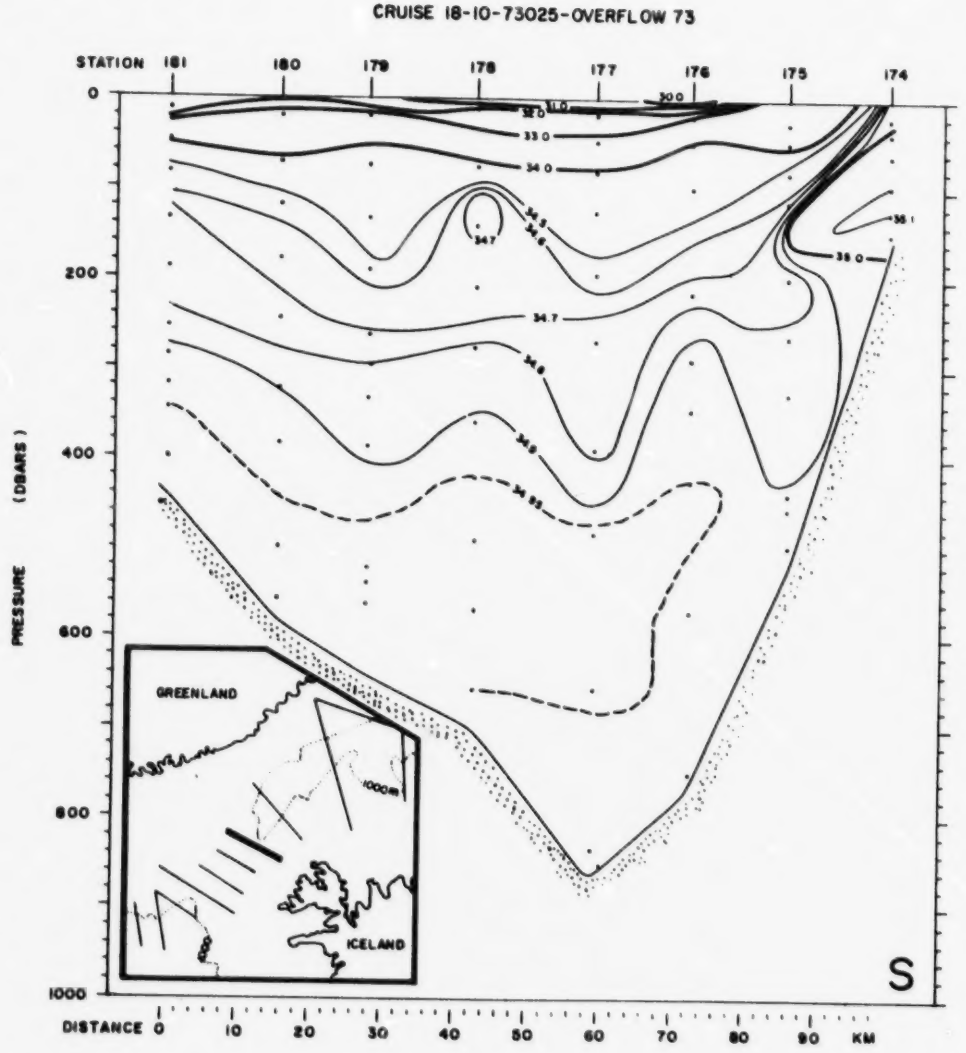

CRUISE 18-10-73025-OVERFLOW 73
STATION 120 119 118 117 116 115 114 113 112 111
PRESSURE (DBARS)
0
200
400
600
800
1000
DISTANCE 0 25 50 75 100 125 KM
GREENLAND
ICELAND
S


CRUISE 18-10-73025 - OVERFLOW 73
STATION 145 144 143 142 141 140 139 138
0
500
1000
1500
2000
2500
PRESSURE (DBARS)
DISTANCE 0 25 50 75 100 KM
S
GREENLAND
ICELAND

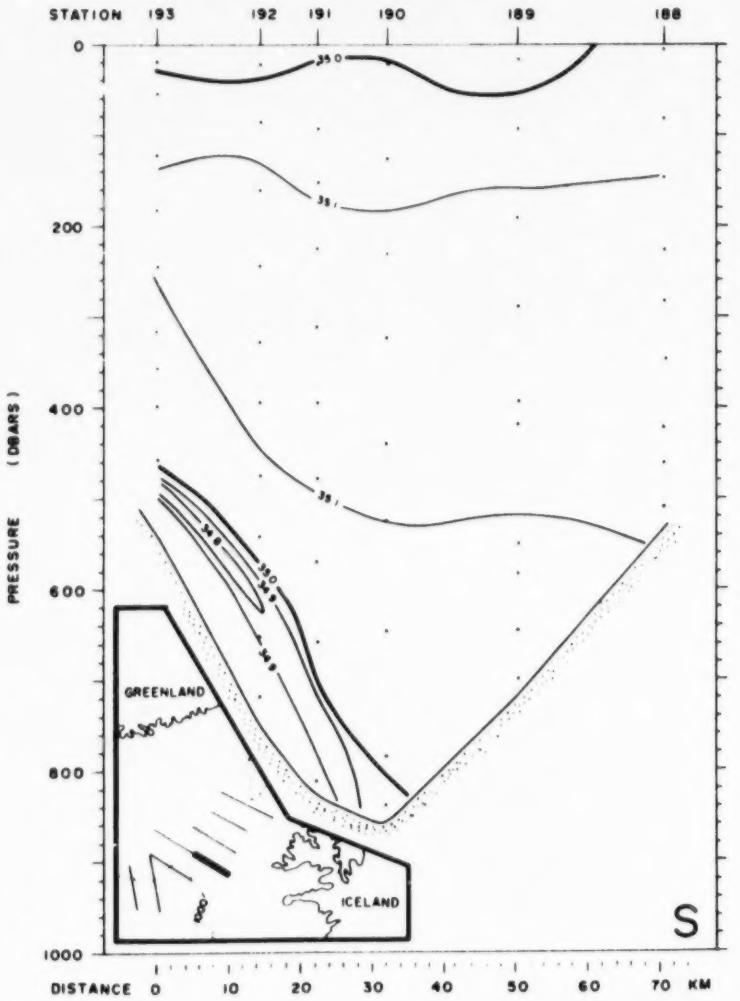

CRUISE 18 - 10 - 73025 - OVERFLOW 73
STATION 157 156 155 154 153 152 151 150 149 148 147
PRESSURE (DBARS)
0
200
400
600
800
1000
DISTANCE 0 25 50 75 100 125 KM
33.0
34.0
34.0
34.5
34.8
34.9
34.9
34.8
34.7
34.6
35.1
35.1
35.0
34.9
34.9
35.1
GREENLAND
ICELAND
S

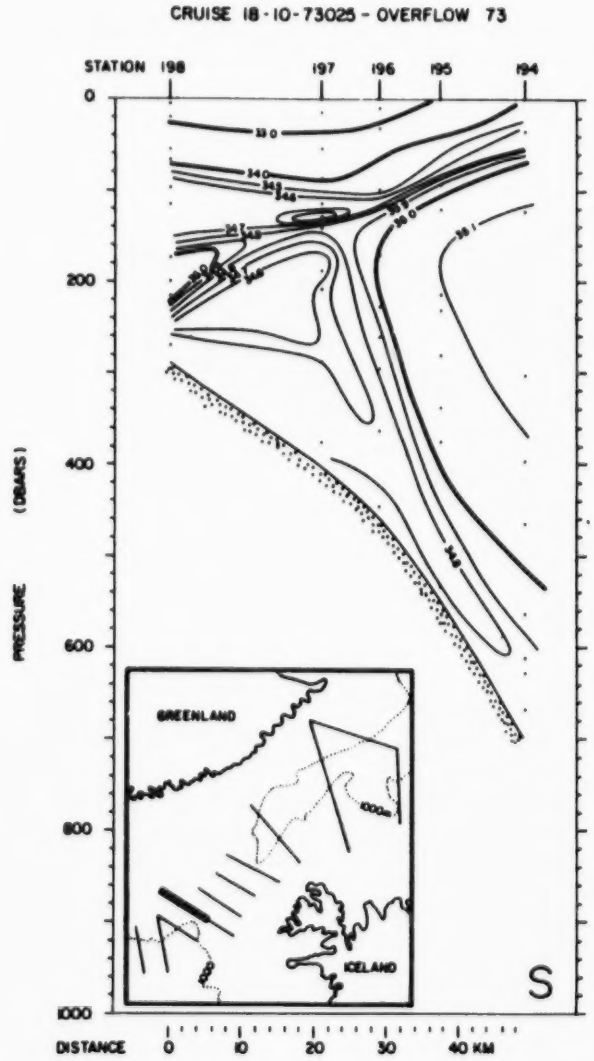
CRUISE 18-10-73025 - OVERFLOW 73

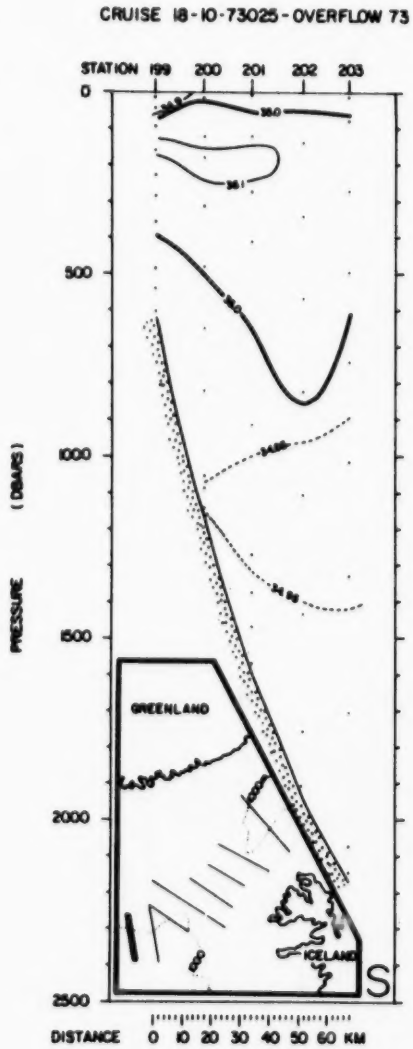



CRUISE 18-10-73025-OVERFLOW 73
STATION 181 180 179 178 177 176 175 174
0
200
400
600
800
1000
PRESSURE (DBARS)
32.0
33.0
34.0
34.5
34.6
34.7
34.8
34.9
34.92
35.0
35.1
GREENLAND
1000m
ICELAND
S
DISTANCE 0 10 20 30 40 50 60 70 80 90 KM

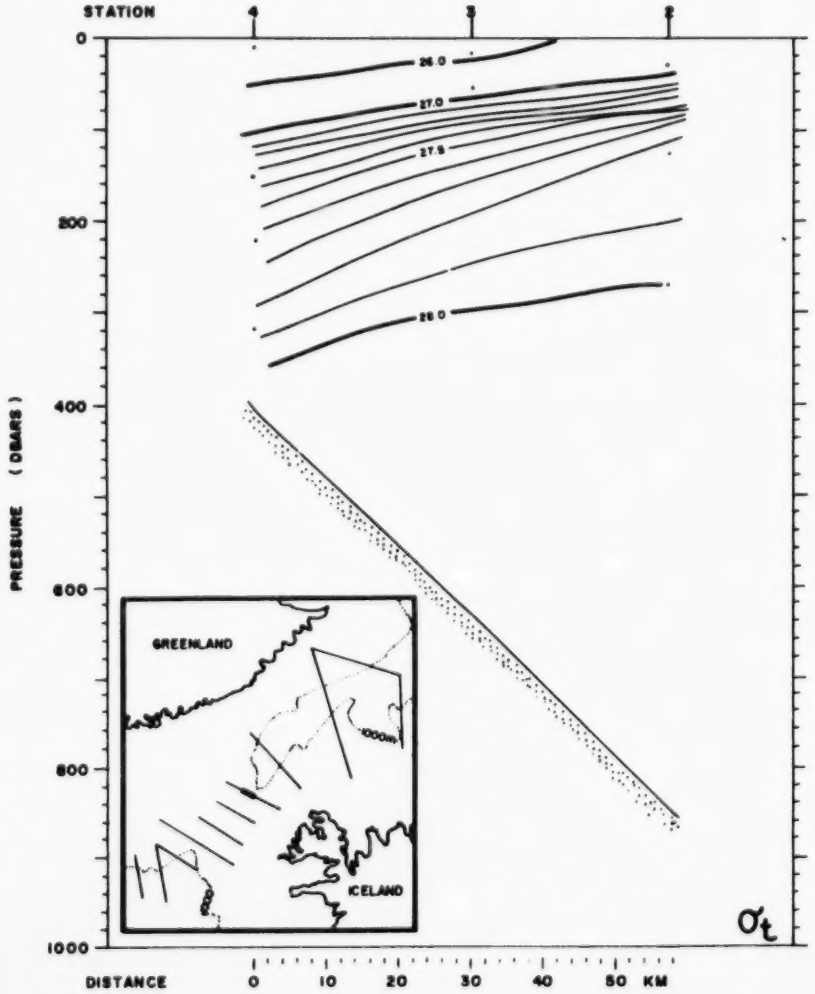
CRUISE 18-10-73025-OVERFLOW 73



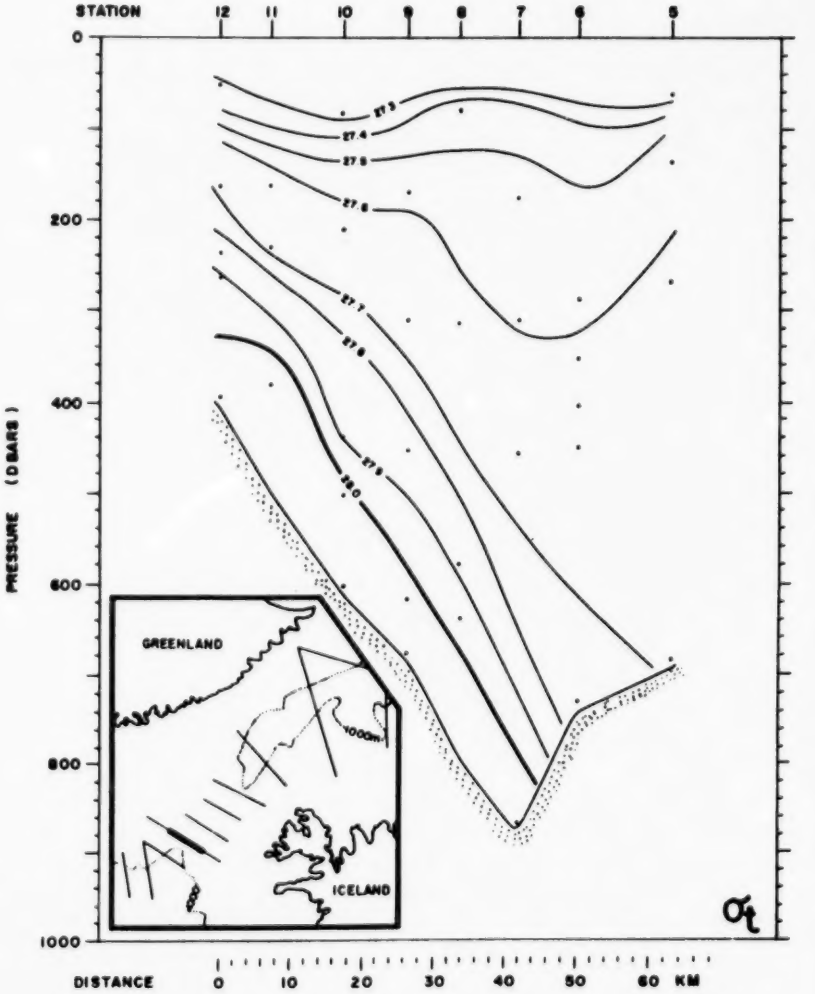

CRUISE 18-10-73025 - OVERFLOW 73
STATION 198 197 196 195 194
PRESSURE (DBARS)
0
200
400
600
800
1000
DISTANCE 0 10 20 30 40 KM
GREENLAND
ICELAND
S

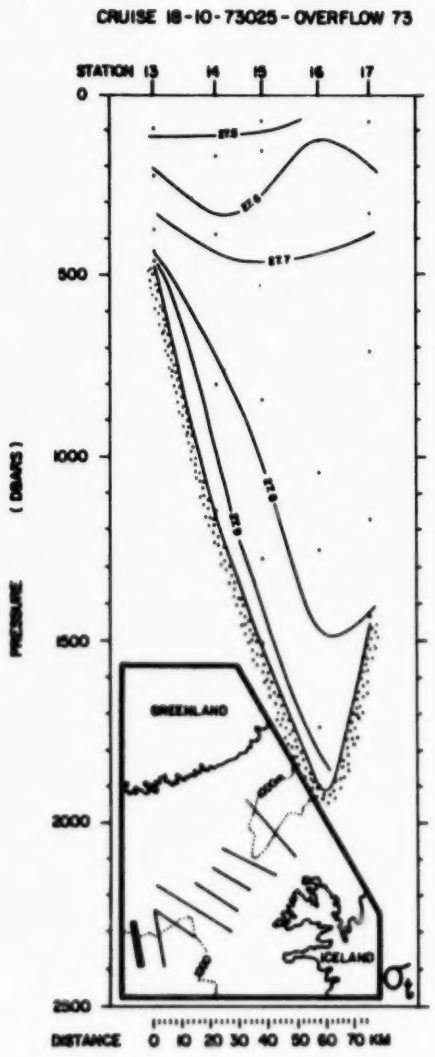

CRUISE 18-10-73025 - OVERFLOW 73
STATION 199 200 201 202 203
PRESSURE (DBARS)
0
500
1000
1500
2000
2500
DISTANCE 0 10 20 30 40 50 60 KM
GREENLAND
ICELAND
S

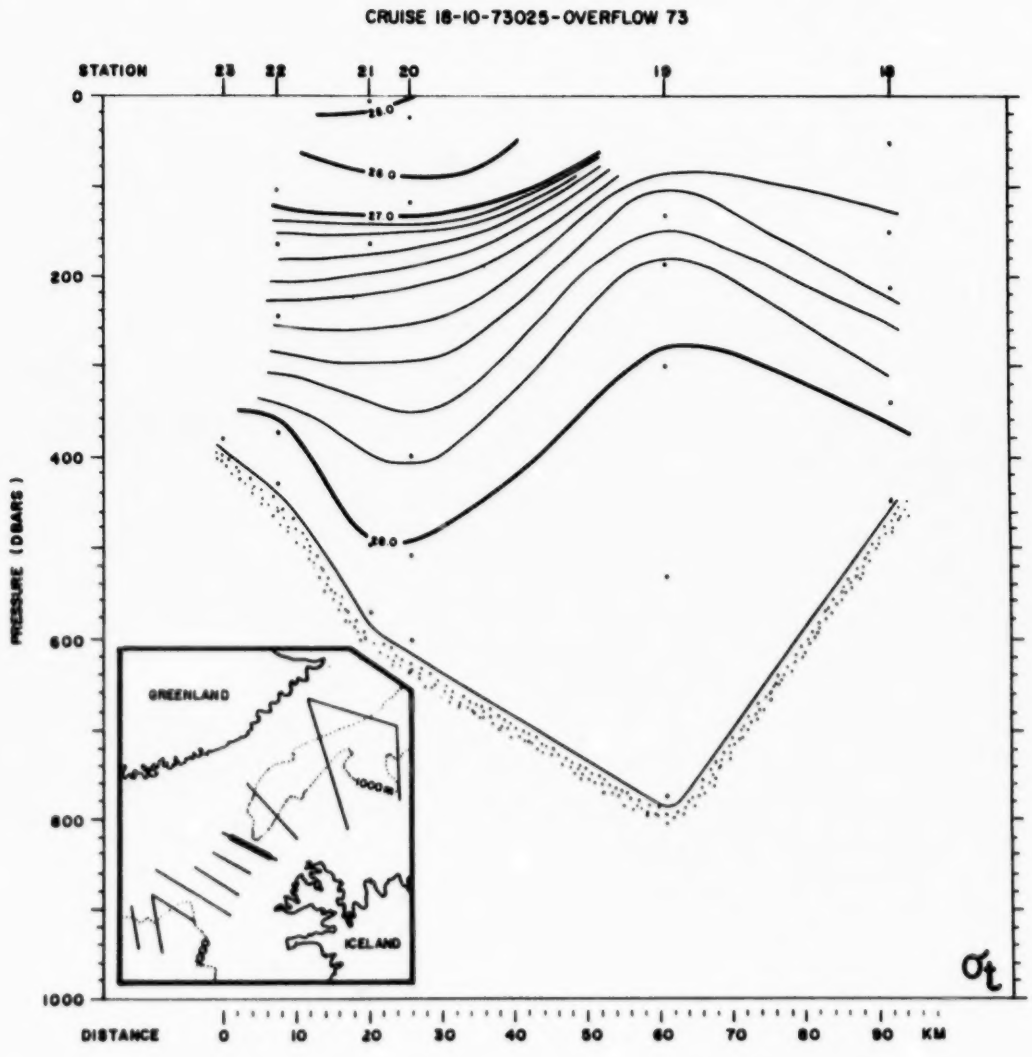
CRUISE 18-10-73025-OVERFLOW 73

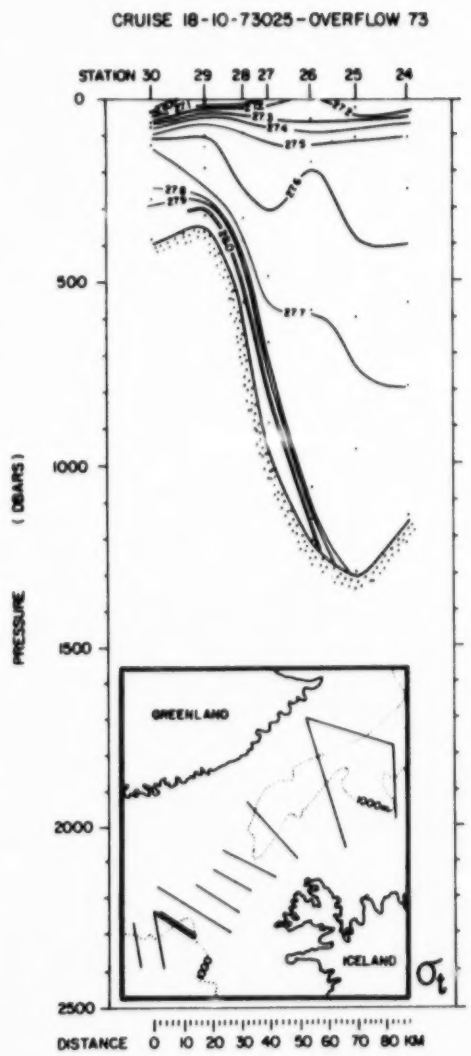


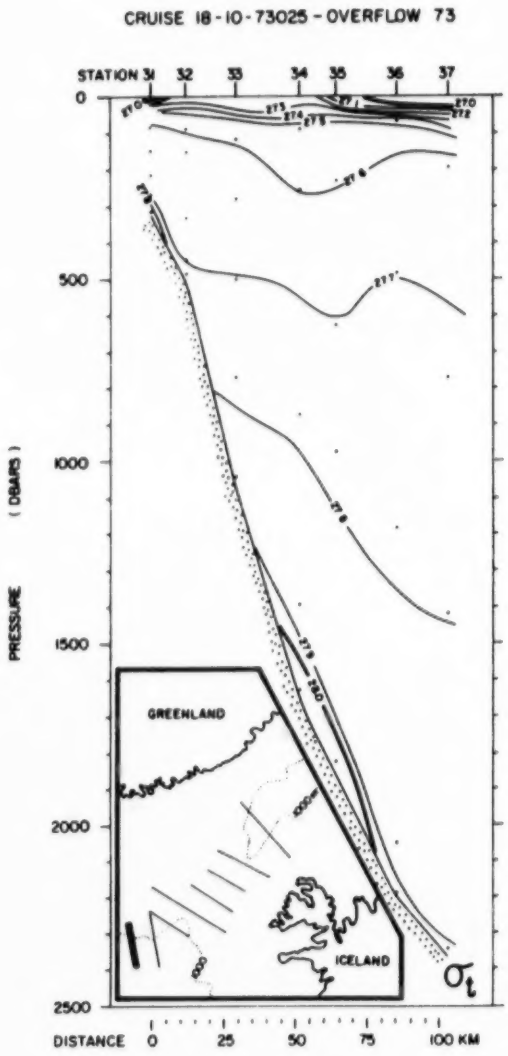
CRUISE 18-10-73025-OVERFLOW 73

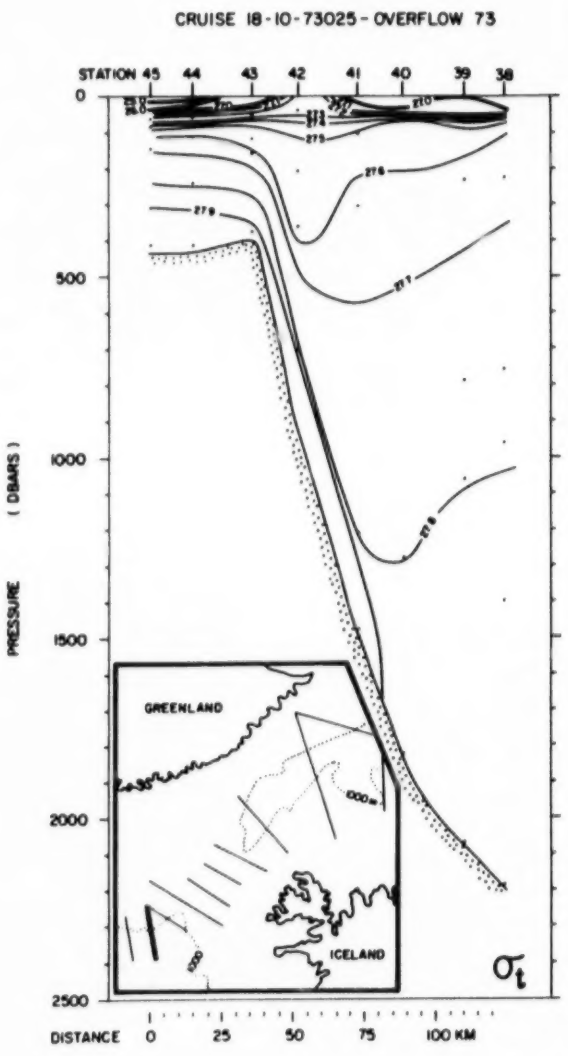


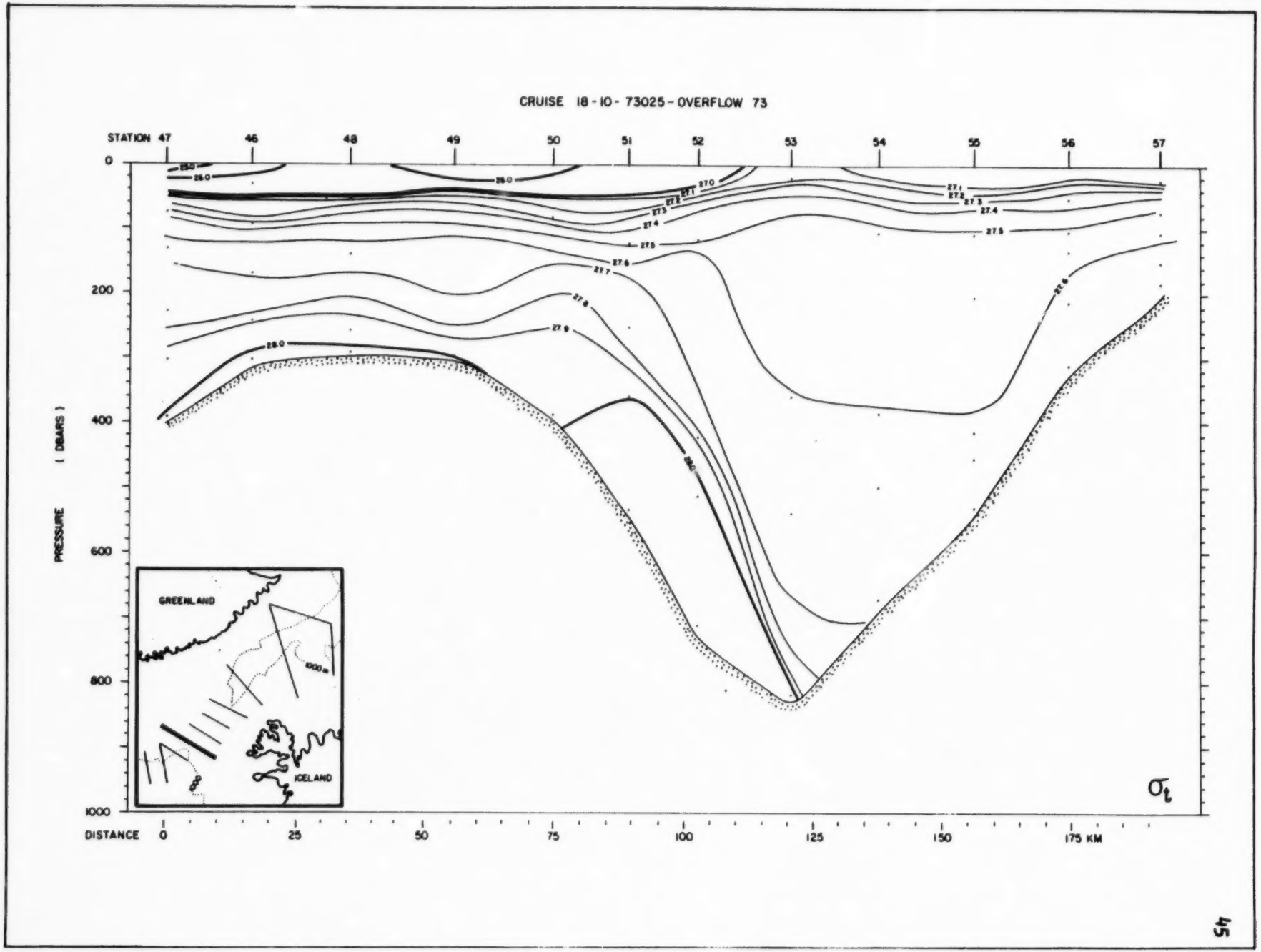

CRUISE 18-10-73025 - OVERFLOW 73
STATION 13 14 15 16 17
0
500
1000
1500
2000
2500
PRESSURE (DBARS)
27.5
27.6
27.7
27.8
27.9
GREENLAND
ICELAND
σ_t
DISTANCE 0 10 20 30 40 50 60 70 KM


CRUISE 18-10-73025 - OVERFLOW 73
STATION 23 22 21 20 19 18
0
200
400
600
800
1000
PRESSURE (DBARS)
26.0
27.0
28.0
GREENLAND
1000m
ICELAND
σ_t
DISTANCE 0 10 20 30 40 50 60 70 80 90 KM

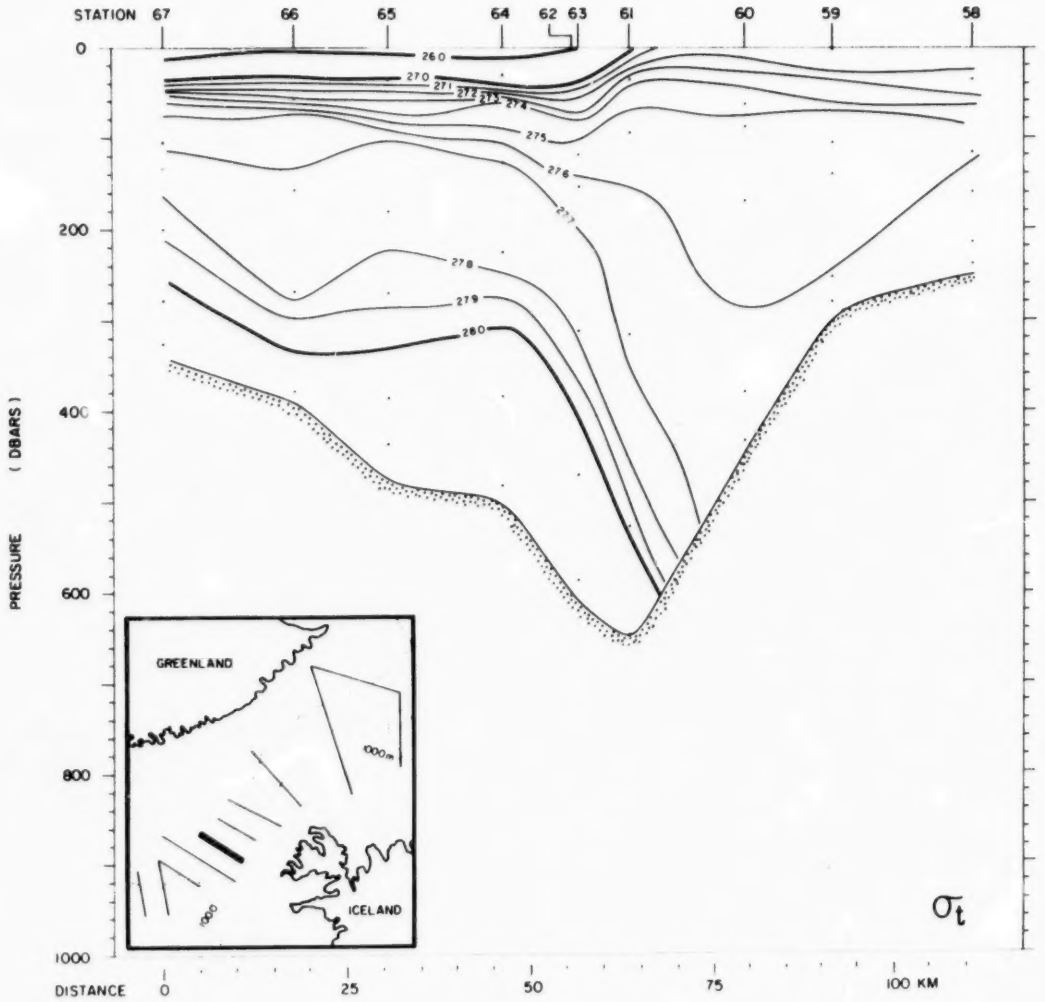

CRUISE 18-10-73025-OVERFLOW 73
STATION 30 29 28 27 26 25 24
PRESSURE (DBARS)
0
500
1000
1500
2000
2500
DISTANCE 0 10 20 30 40 50 60 70 80 KM
GREENLAND
ICELAND
σ_t


CRUISE 18-10-73025-OVERFLOW 73
STATION 31 32 33 34 35 36 37
PRESSURE (DBARS)
0
500
1000
1500
2000
2500
DISTANCE 0 25 50 75 100 KM
GREENLAND
ICELAND
σ_t

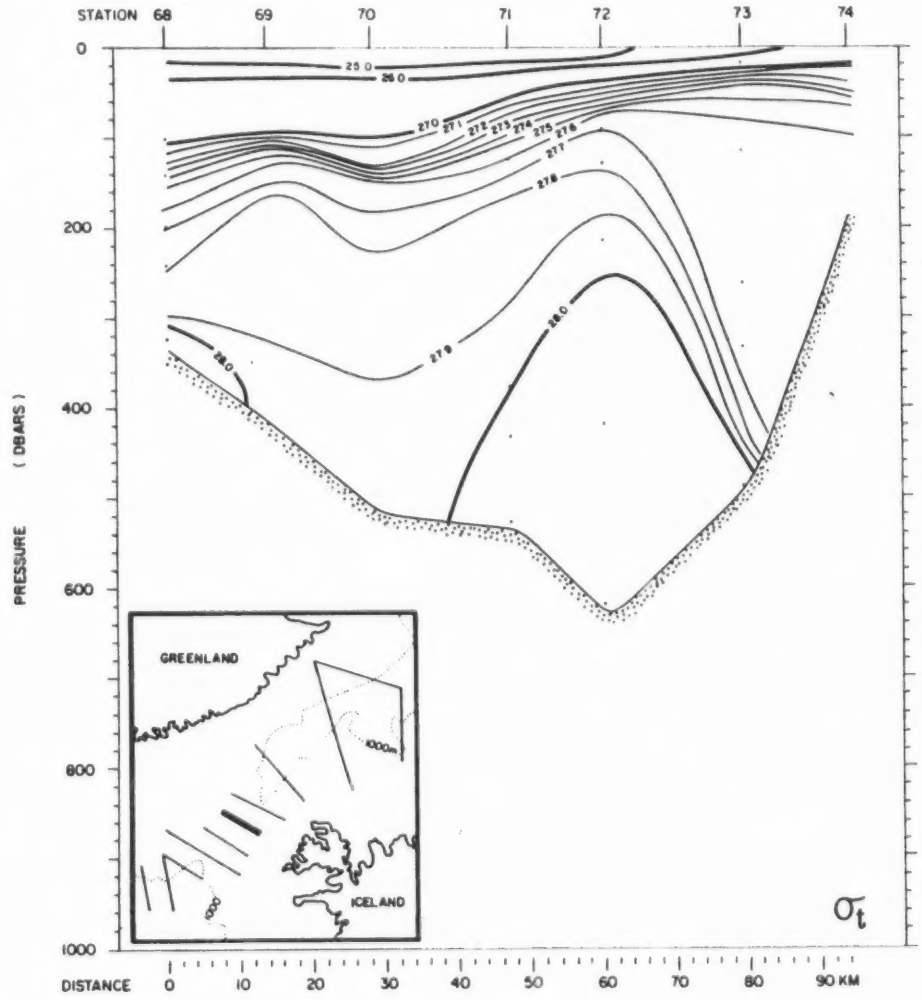

CRUISE 18-10-73025-OVERFLOW 73
STATION 45 44 43 42 41 40 39 38
PRESSURE (DBARS)
0
500
1000
1500
2000
2500
DISTANCE 0 25 50 75 100 KM
GREENLAND
ICELAND
σ_t


CRUISE 18-10-73025-OVERFLOW 73
STATION 47 46 48 49 50 51 52 53 54 55 56 57
PRESSURE (DBARS)
0
200
400
600
800
1000
DISTANCE 0 25 50 75 100 125 150 175 KM
GREENLAND
ICELAND
1000 m
σ_t

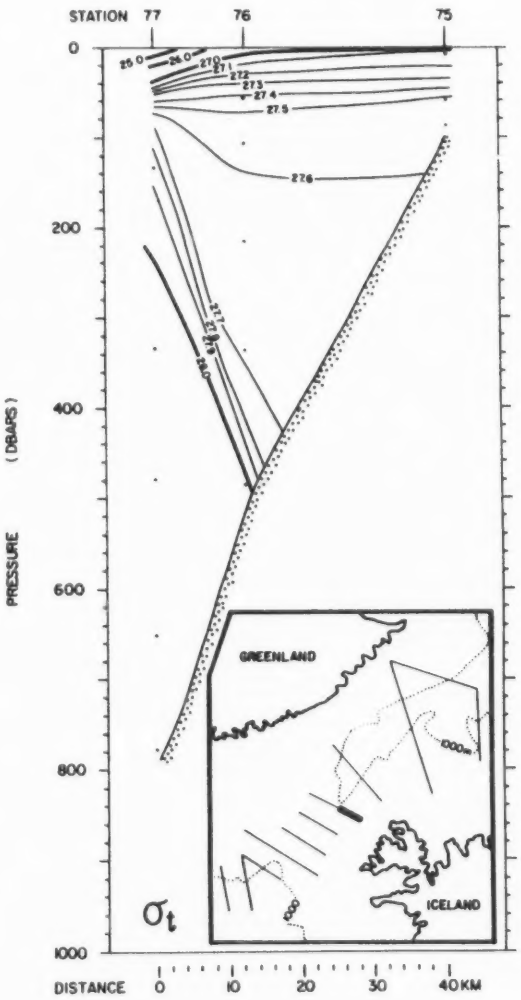
CRUISE 18-10-73025 - OVERFLOW 73



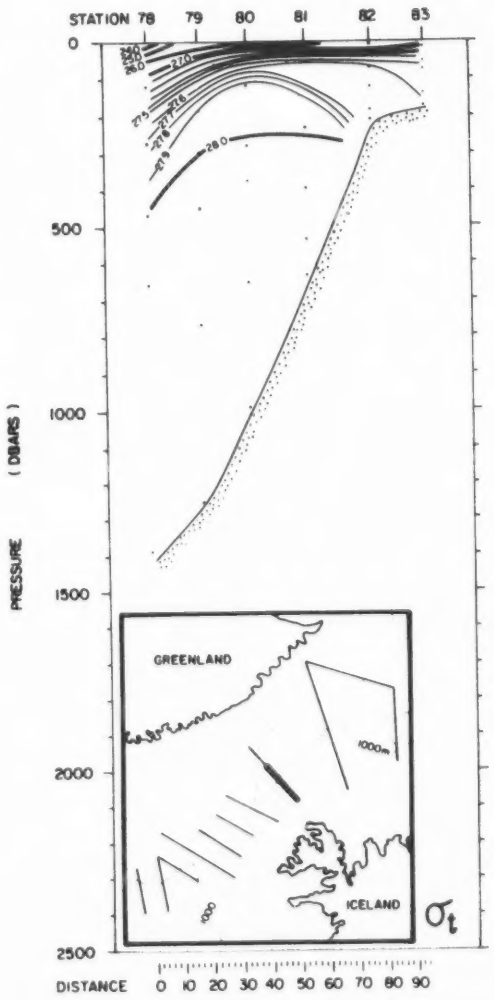
CRUISE 18-10-73025 - OVERFLOW 73



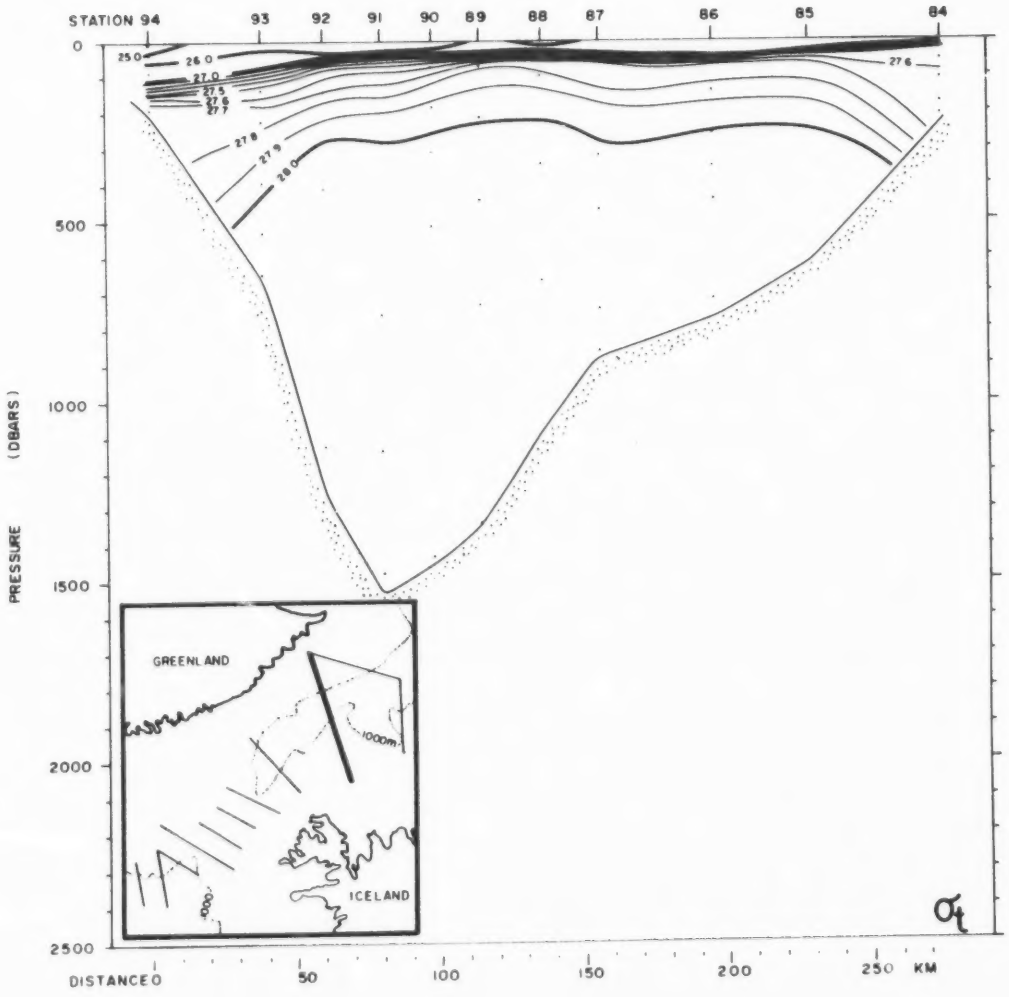
CRUISE 18-10-73025 - OVERFLOW 73



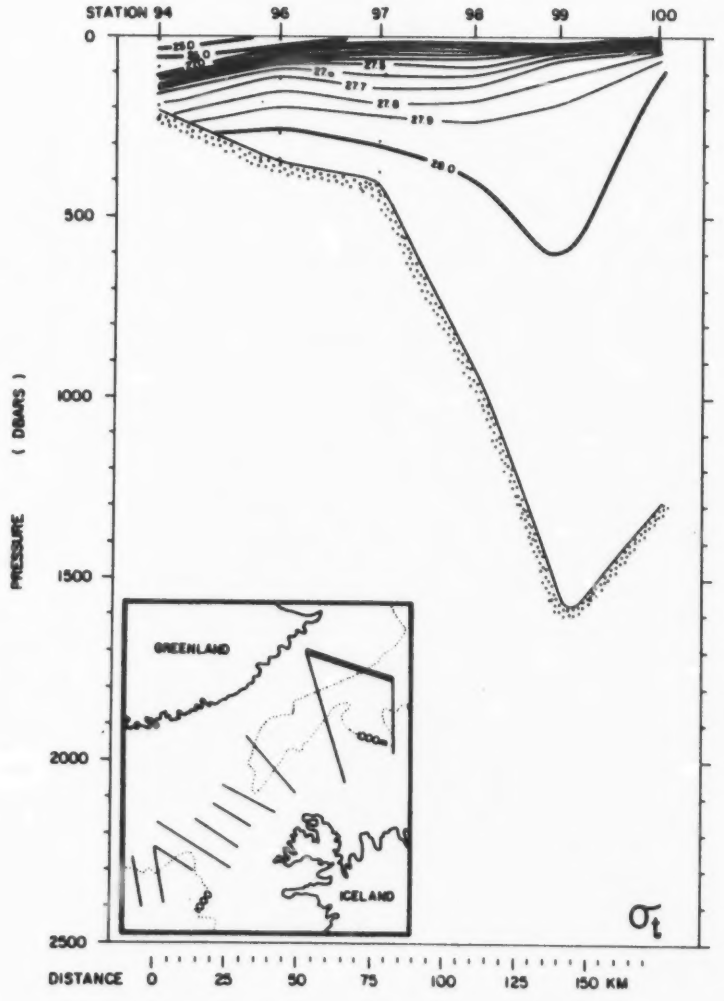
CRUISE 18-10-73025-OVERFLOW 73



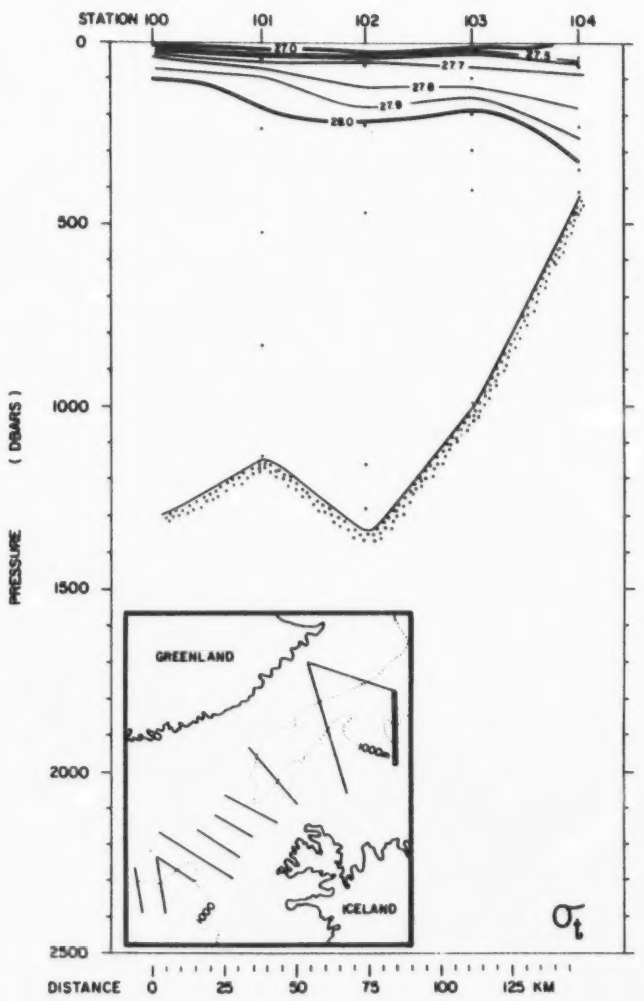
CRUISE 18-10-73025-OVERFLOW 73

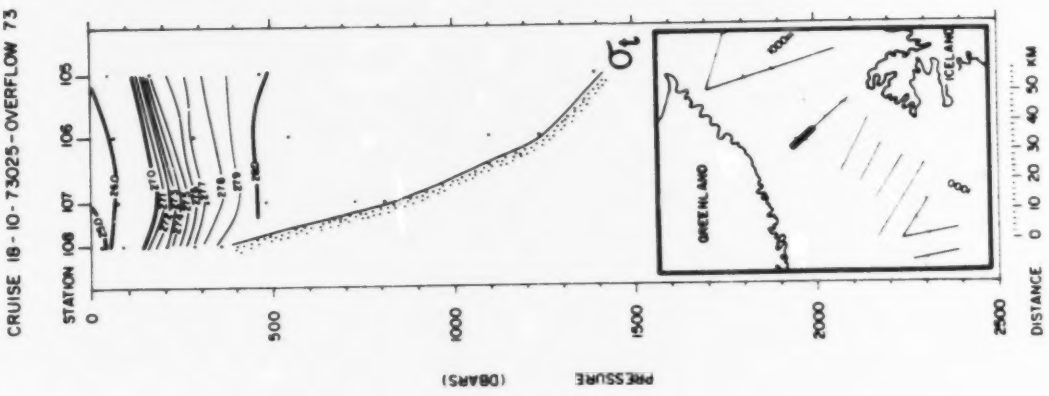


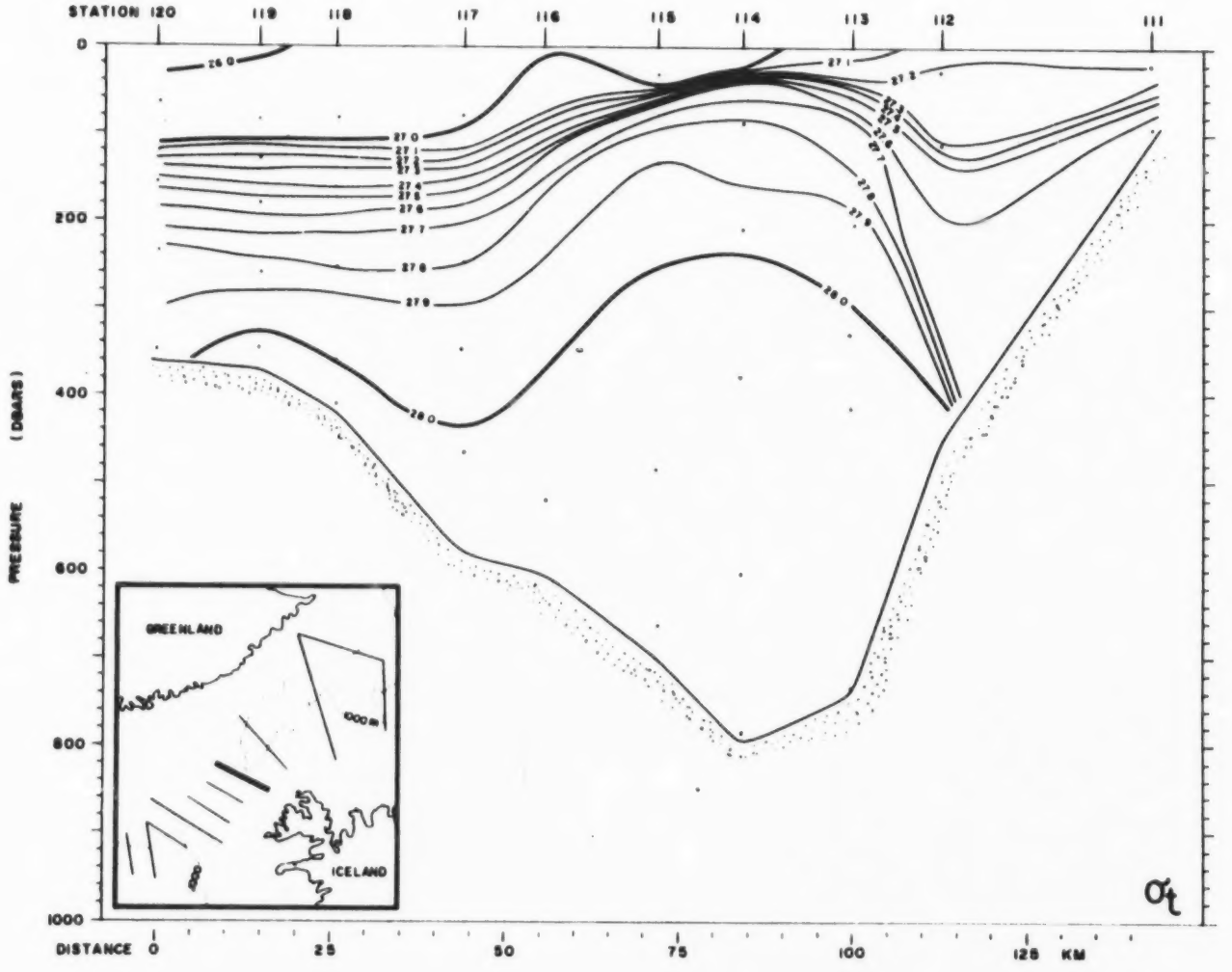
CRUISE 18-10-73025 - OVERFLOW 73

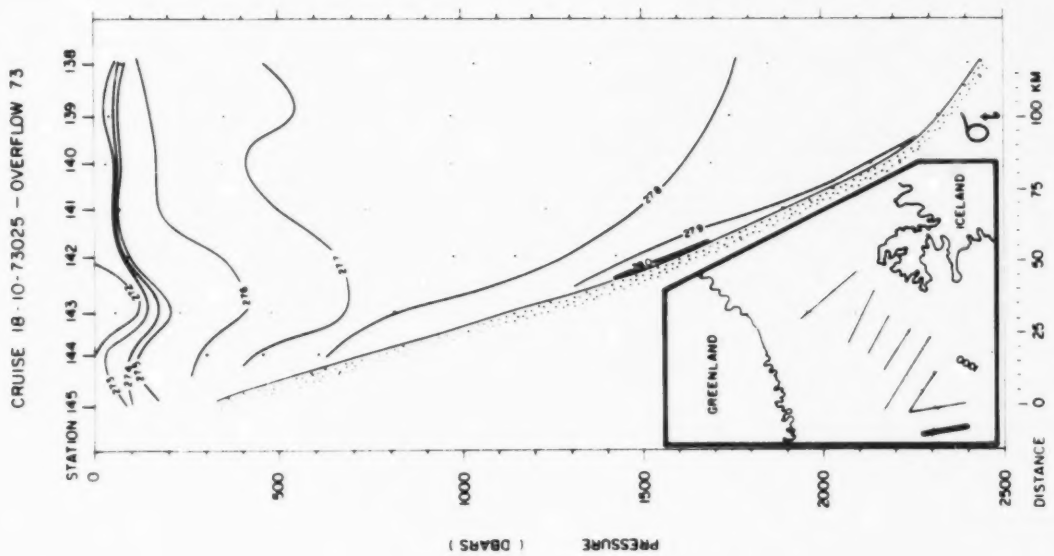


CRUISE 18-10-73025 - OVERFLOW 73

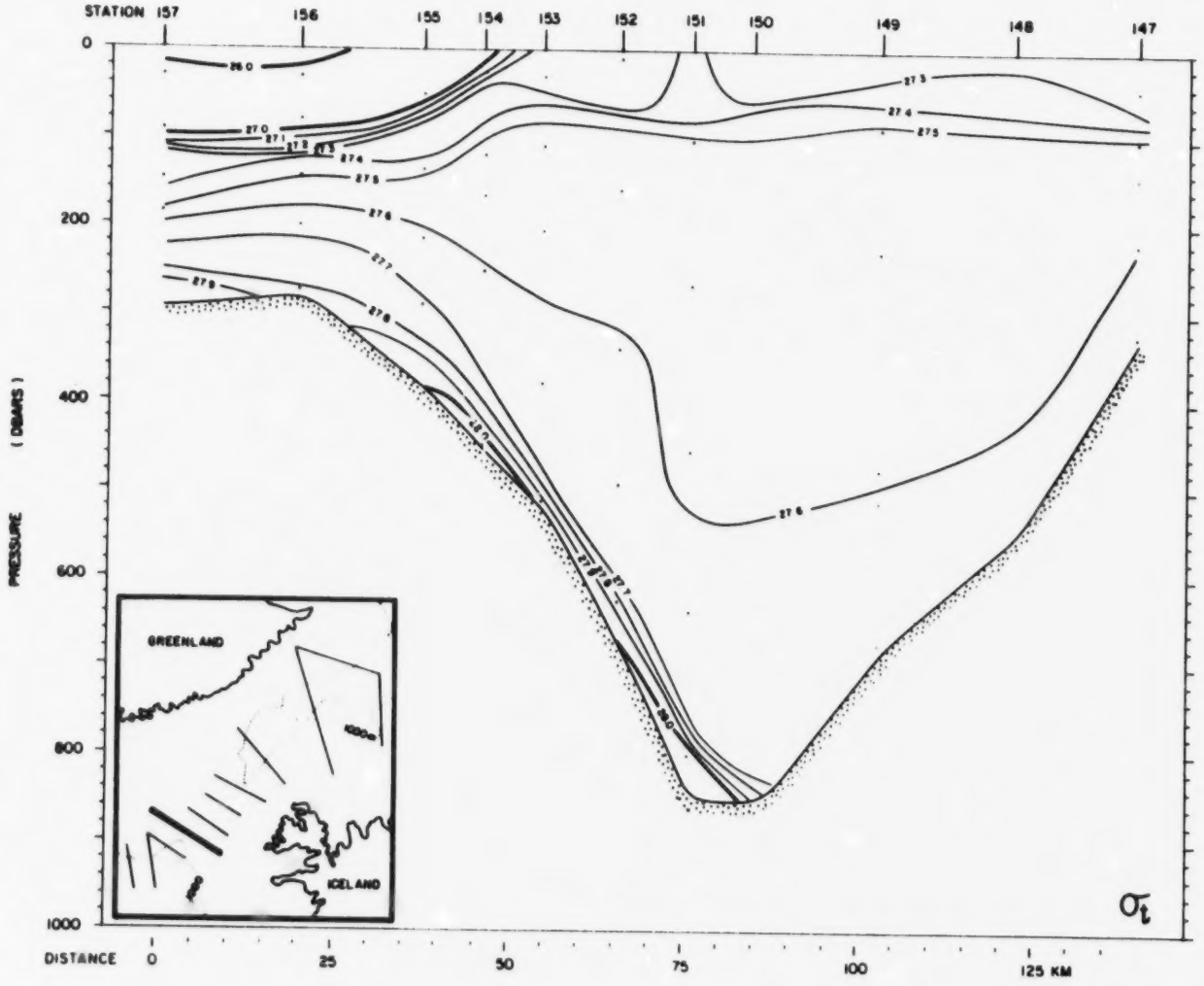


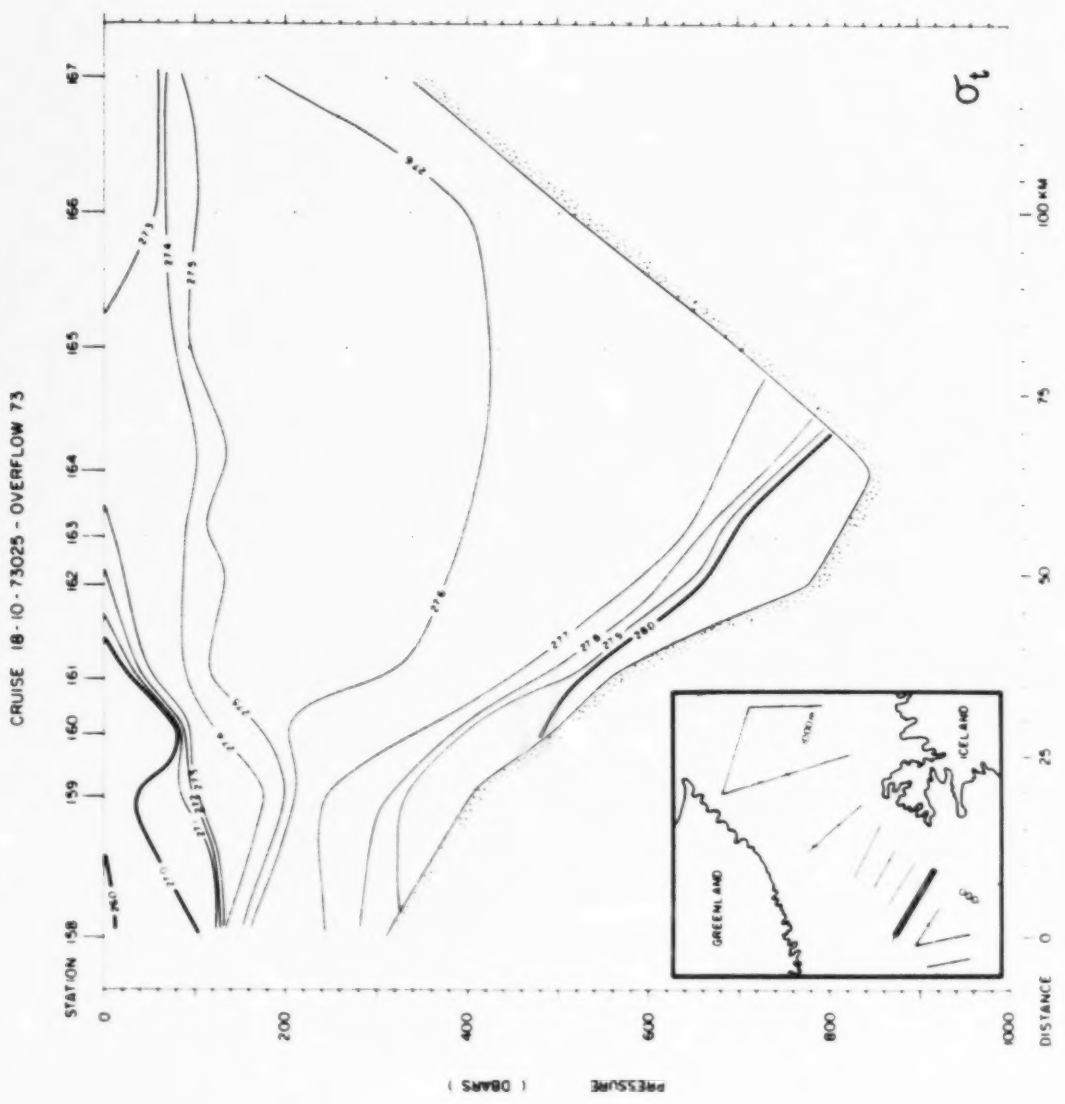

CRUISE 18-10-73025-OVERFLOW 73
STATION 108 107 106 105
0
500
1000
1500
2000
2500
PRESSURE (DBARS)
σ_t
GREENLAND
ICELAND
DISTANCE 0 10 20 30 40 50 KM


CRUISE 18-10-73025-OVERFLOW 73
STATION 120
119
118
117
116
115
114
113
112
111
0
200
400
600
800
1000
PRESSURE (DBARS)
DISTANCE 0
25
50
75
100
125 KM
GREENLAND
ICELAND
σt

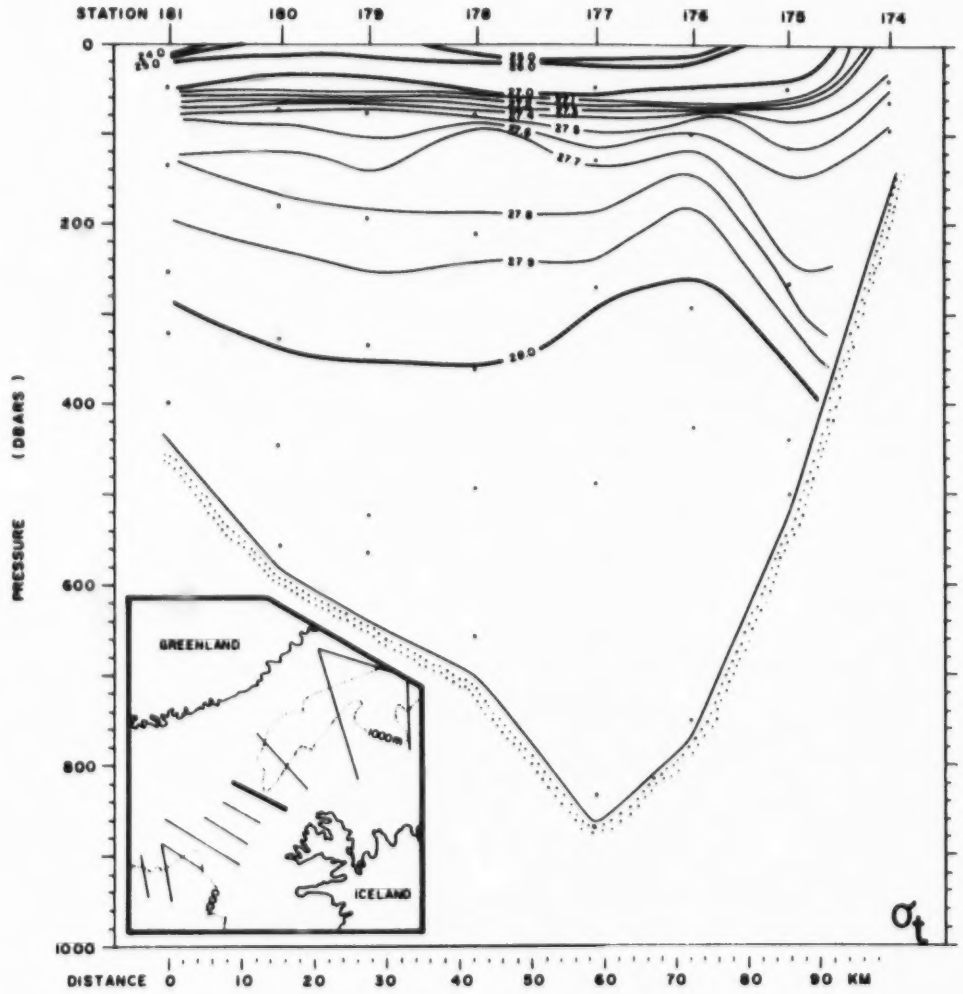

CRUISE 18-10-73025 – OVERFLOW 73
STATION 145 144 143 142 141 140 139 138
0
500
1000
1500
2000
2500
PRESSURE (DBARS)
DISTANCE 0 25 50 75 100 KM
GREENLAND
ICELAND
σ_t

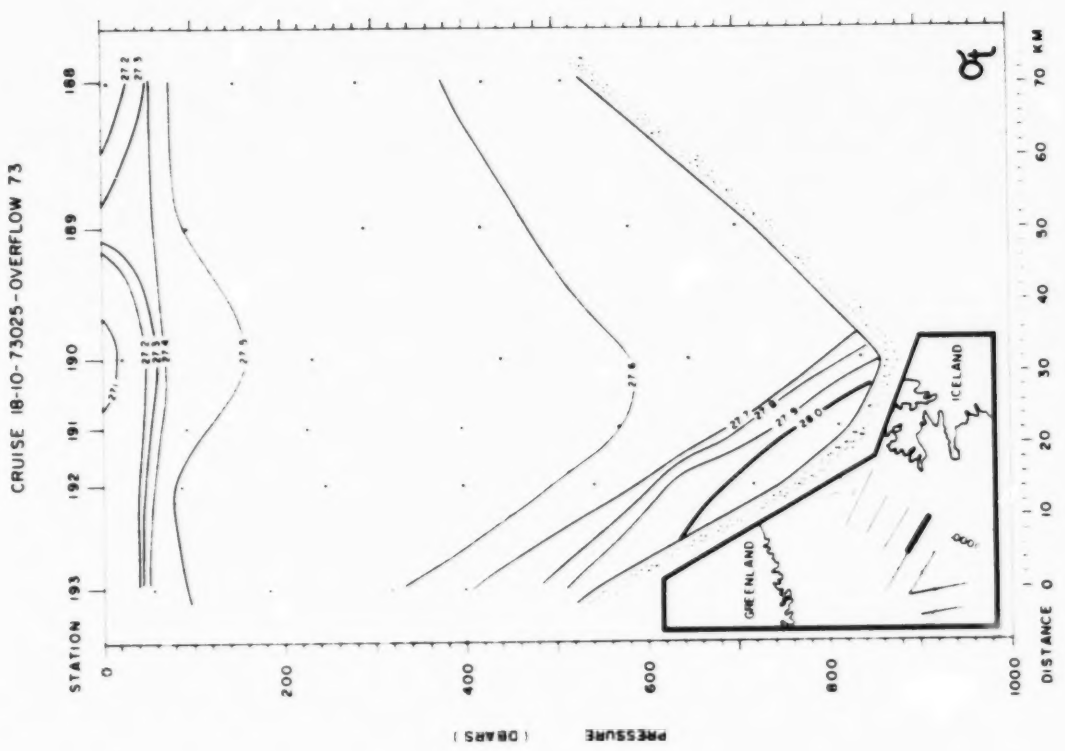
CRUISE 18-10-73025 - OVERFLOW 73

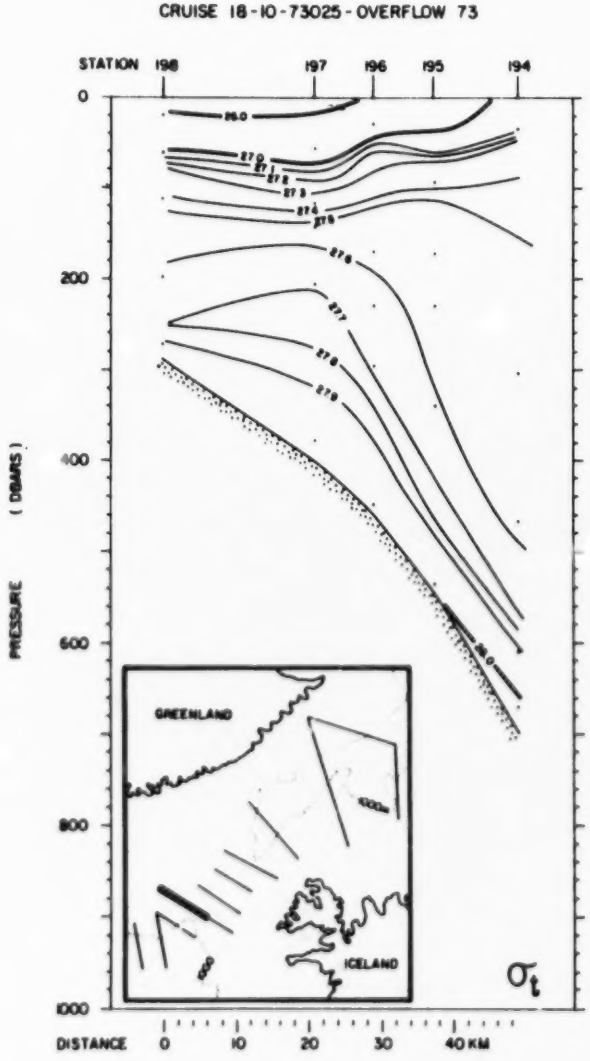


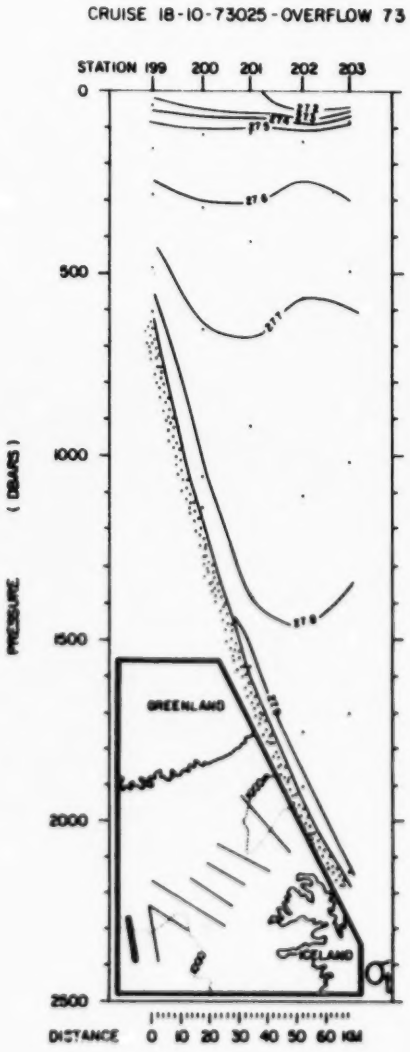

CRUISE 18-10-73025 - OVERFLOW 73
STATION 158 159 160 161 162 163 164 165 166 167
0 200 400 600 800 1000
DISTANCE 0 25 50 75 100 KM
PRESSURE (DBARS)
GREENLAND
ICELAND
σ_t

CRUISE 18-10-73025-OVERFLOW 73




CRUISE 18-10-73025-OVERFLOW 73
STATION 193 192 191 190 189 188
DISTANCE 0 10 20 30 40 50 60 70 KM
PRESSURE (DBARS)
0 200 400 600 800 1000
GREENLAND
ICELAND
27.1
27.2
27.3
27.4
27.5
27.6
27.7
27.8
27.9
28.0


CRUISE 18-10-73025 - OVERFLOW 73
STATION 198 197 196 195 194
PRESSURE (DBARS)
0
200
400
600
800
1000
DISTANCE 0 10 20 30 40 KM
GREENLAND
ICELAND
σ_t


CRUISE 18-10-73025 - OVERFLOW 73
STATION 199 200 201 202 203
PRESSURE (DBARS)
0
500
1000
1500
2000
2500
DISTANCE 0 10 20 30 40 50 60 KM
GREENLAND
ICELAND
σ_t

POOR

QUALITY

ORIGINAL